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AMERICAN

DYESTUFF REPORTER

DEVOTED TO TEXTILE WET-PROCESSING

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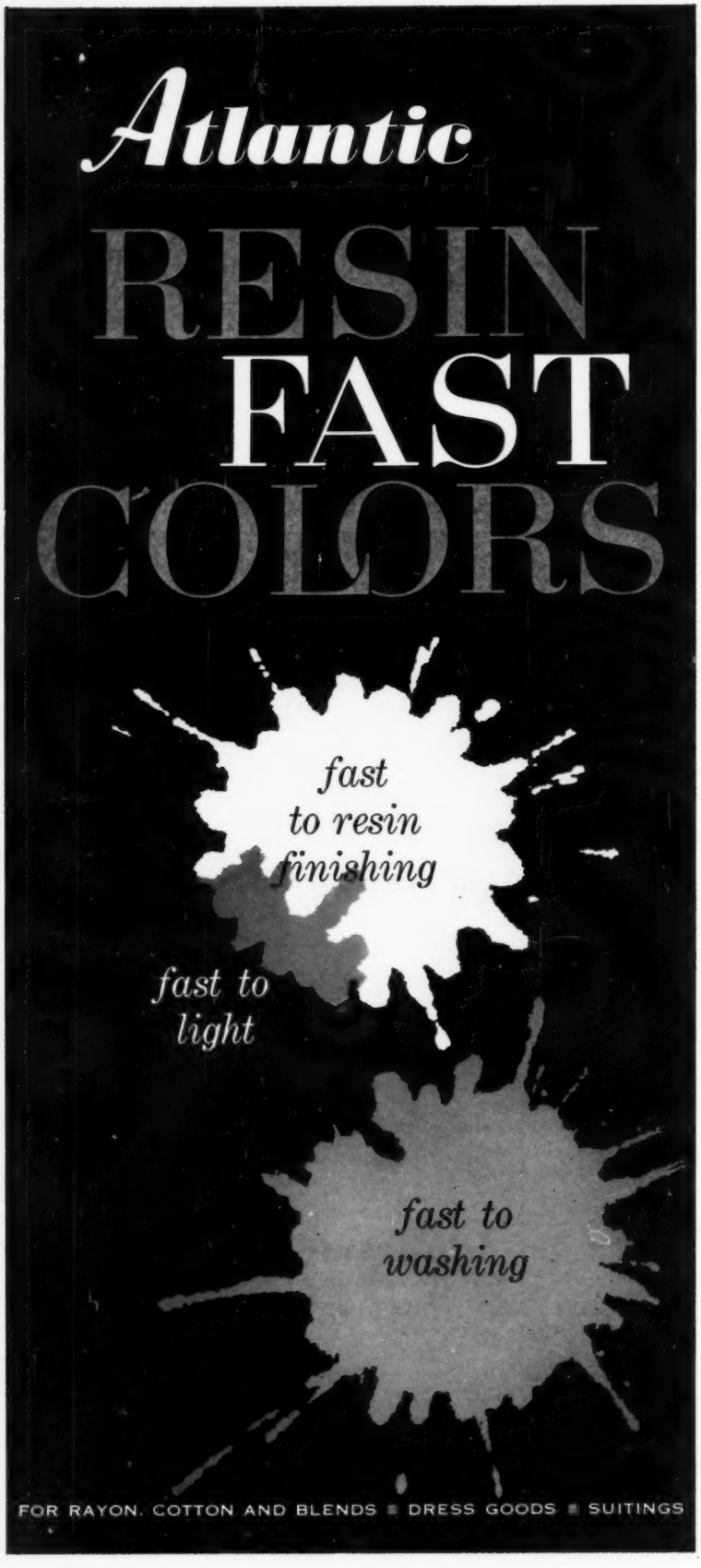
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AMERICAN

DYESTUFF REPORTER

Volume 49 June 13, 1960 No. 12

PATHWAYS OF CAPILLARY MIGRATION OF LIQUIDS IN TEXTILE ASSEMBLIES

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Army Chemical Center, Md

INTRODUCTION

ALTHOUGH there is considerable literature on the absorption and transport of aqueous liquids in fibrous structures, relatively little has been published concerning the analogous behavior of non-aqueous organic liquids. In connection with certain Chemical Corps research studies it became necessary to obtain a better understanding of the mechanics and and physical chemistry of the flow of such organic liquids in textile materals. Particular interest centered on the entry and movement of individual droplets of liquid, 50 mg or less, within standard woven or knitted apparel fabrics. Droplets of this size, unlike larger masses of liquid, are not usually impelled by continuous external pressures, nor are their movements influenced primarily by gravity. The primary driving forces responsible for their movement are the forces of capillarity, originating from the surface and interfacial tensions at the phase interfaces of the system.

In any system where capillarity is causing relative motion between a solid and a liquid, the shape of the solid surfaces is an important factor governing the rate and direction of liquid flow. Thus the complex contours formed by the fibers in a yarn and the yarns in a fabric constitute the boundaries of the channels along which the liquid flows. One of the purposes of the present studies was to describe these pathways and to consider their relative importance as carriers of liquid. A second purpose was to determine if these complex systems might, under certain circumstances, follow the same general laws that govern capillary flow in simple cylindrical tubes.

DISCUSSION

The construction of a textile fabric can be regarded as providing three distinct capillary systems in which liquid may travel after the liquid has wet and entered the body of the fabric. These are mutually perpendicular, one in the warp direction in the plane of the fabric, C_w, the second in the filling direction in the plane of the fabric, C_f, and the third extending the very short distance through the thickness of the fabric, C_t. It is apparent that, when a liquid enters a textile, it enters all three capillary systems, and the rate at which liquid migrates in each direction will depend on the relative geometrical characteristics of C_w, C_f, and C_t. These capillary systems differ markedly from the cylindrical tubes which are usually treated in the elementary theory of capillarity. The channels formed by the interyarn and interfiber spaces are not cylindrical. Most frequently they are not even closed at either the sides or the ends. They might, however, be considered as analagous to a series of tubes, in which case their size could presumably be expressed by an "equivalent radius" (*1*). The capillary flow within a given liquid-fabric system could then be described within limits as a function of the equivalent radius and the physical properties of the liquid. The major liquid properties which influence capillary flow are viscosity, surface tension, contact angle against the solid and density, all of which can be measured experimentally. The problem therefore resolves itself into finding out whether the concept of an equivalent radius is valid and applicable to the systems C_w, C_f, C_t, and if so whether their equivalent radii can be evaluated quantitatively.

In classical capillarity theory the rate of rise of a liquid in a vertical cylindrical capillary tube, assuming the absence of wall slippage effects, is given by the following equation developed by Washburn (*2*):

$$\frac{ds}{dt} = \frac{2\gamma \cos \Theta - gDS}{r} \cdot \frac{r^2}{8\eta S} \qquad \text{(Eq 1)}$$

where s = height of rise
t = time
r = radius of capillary
γ = surface tension of liquid
Θ = contact angle of liquid with capillary wall
g = gravitational constant
D = density of liquid
η = viscosity of liquid

If the effect of gravity is negligible, as it was under the conditions of most of the experimental work to be described, the Washburn equation may be written in the form:

$$\frac{ds}{dt} = \frac{2\gamma\, r \cos \Theta}{8\eta S} \qquad \text{(Eq 2)}$$

Since, by definition, r Θ and η have fixed values this equation may be further simplified to the form

$$\frac{ds}{dt} = \frac{k}{s} \qquad \text{(Eq 3)}$$

which can be integrated to the form

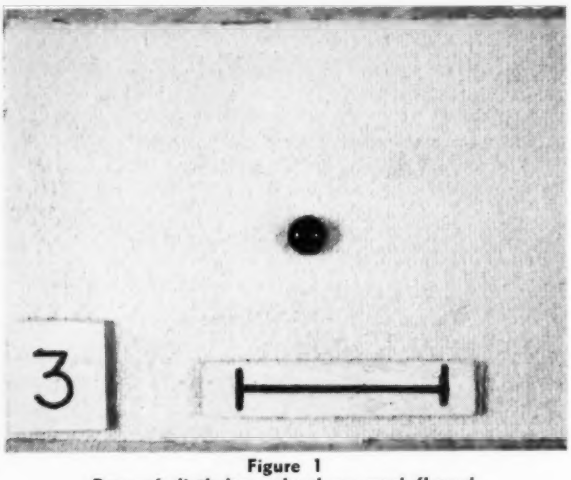

Figure 1
Drop of diethylene glycol on wool flannel. Drop size: 28 mg. Bar represents one inch.

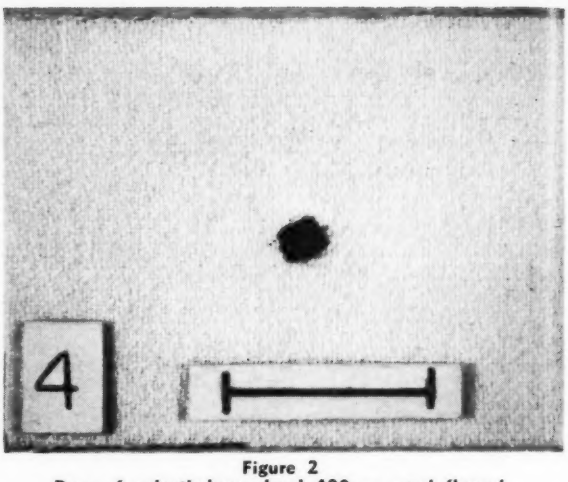

Figure 2
Drop of polyethylene glycol 400 on wool flannel. Drop size: 28 mg. Bar represents one inch.

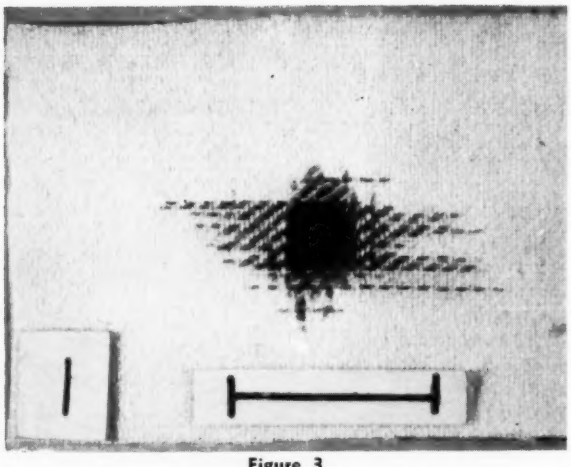

Figure 3
Drop of 2-anilino-ethanol on wool flannel. Drop size: 28 mg. Bar represents one inch.

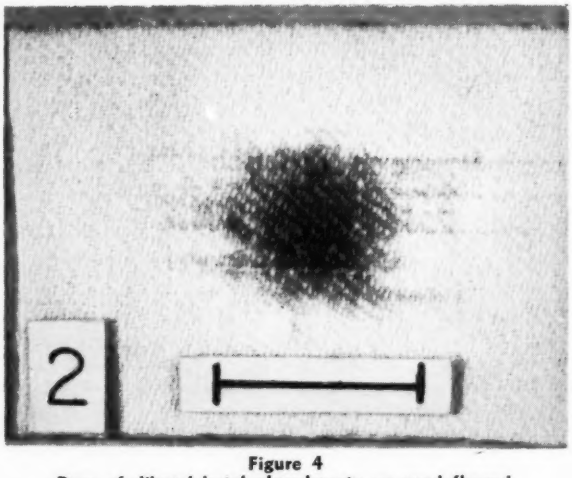

Figure 4
Drop of dibutyl butyl phosphonate on wool flannel. Drop size: 18 mg. Bar represents one inch.

$$s^2 = k't. \qquad \text{(Eq 4)}$$

Thus a plot of s^2 against t (or s against $\sqrt{t}$) should be a straight line in any system where the conditions implicitly postulated in the Washburn equation hold. These conditions are 1) that the physical properties of the liquid and solid remain constant throughout the system (to assure constancy of contact angle, etc); 2) that the driving forces are forces of capillarity; 3) that the radius of the tube or the equivalent radius of a nontubular system is substantially constant; and 4) that the supply of liquid to the system remains adequate. Conversely, when straight line plots of s^2 vs t are obtained in any complex capillary system, it supports the assumption that this system is analogous to a narrow cylindrical tube, follows Washburn's equation, and can be assigned an equivalent radius. Straight-line plots of this type were obtained in the fabric- and yarn-wicking experiments described below.

The purely descriptive considerations of liquid droplet entry into fabrics and liquid migration at yarn crossings and over yarn surfaces require little theoretical discussion, and are treated in the Experimental Section below.

Another possibility for migration of liquids in textiles, the migration of liquid along a single fiber, will be discussed in a separate paper (*3*).

EXPERIMENTAL OBSERVATIONS

QUALITATIVE BEHAVIOR OF DROPLETS APPLIED TO A FABRIC——In the following examples, drops of nonvolatile liquids, nonreactive with the fiber, were applied to a smoothed-out woolen fabric by means of a pipette or medicine dropper. Depending upon the properties of the fabric and liquid, any of several effects could be observed. The liquid drop may fail to "wet" or enter into the interior of the fabric and remain pearled on the surface of the fabric, as shown with diethylene glycol on wool flannel in Figure 1. When this occurs, the drop may remain pearled on the fabric for various lengths of time and then wet and sink into the fabric. The time required for this to take place will vary from seconds to hours depending on the liquid-fabric system under study. Another possible behavior of the liquid drop is for it to wet and sink into the body of the fabric but fail to wick out rapidly, as shown by polyethylene glycol 400 (Figure 2). The third type of behavior is shown by 2-anilino-ethanol on wool flannel (Figure 3), where the liquid immediately enters the fabric and starts to wick out with appreciable speed. This is also shown in Figure 4 by dibutyl

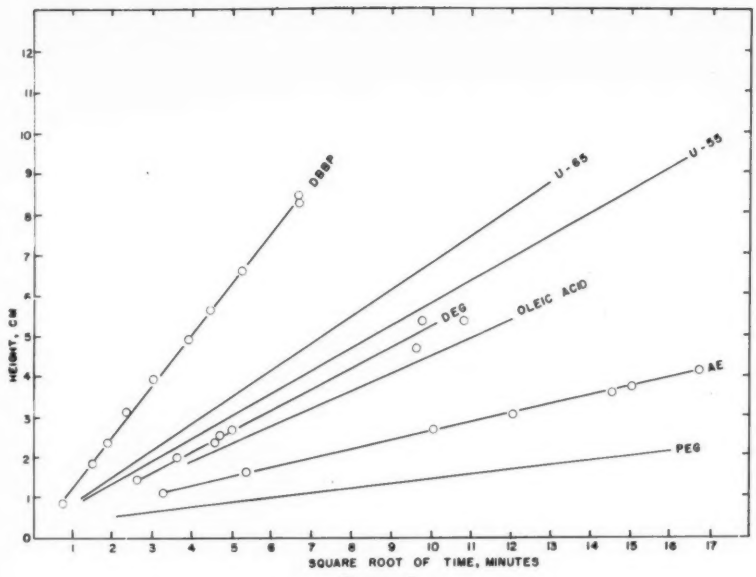

Figure 5
Rise of various liquids in nylon filament yarn. Dibutyl butyl phosphonate (DBBP); Ucon LB-65 (U-65); Ucon 50-HB-55 (U-55); diethylene glycol (DEG); 2-anilino-ethanol (AE); polyethylene glycol 400 (PEG).

butylphosphonate on wool flannel. An examination of Figures 3 and 4 shows that the liquid is being transported mainly within the yarns. The wicking rate in the warp and filling yarns in some systems may differ greatly, forming an elongated pattern as shown in Figure 3. In others, a circular pattern is obtained, as in Figure 4, indicating that the two rates are about equal. These patterns also show that, at times, the liquid can transfer easily from yarn to yarn, while at other times it is difficult. Figure 3, for example, shows several wet horizontal yarns from which liquid has failed to transfer to the vertical yarns.

WICKING IN YARNS——The rate of wicking of several liquids in single yarns made from various fibers was studied. The experimental technique consisted of mounting the yarn by means of clamps at each end of a metal bar, which was then placed vertically into the test liquid with at least one cm of the yarns submerged in the liquid. The liquids were colored with appoximately 0.5% CI Solvent Red 24 dye to make them easily visible. It was previously determined that this dye had no effect on the wicking behavior. The rate of wicking vs time was observed visually. The data obtained were plotted as square root of time vs height of wicking.

The first yarns studied were made of continuous filament nylon and were prepared so as to give as uniform a capillary system as possible. The yarn was cleaned by washing in Dreft solution, followed by extraction with hot alcohol. The cleaned yarn was untwisted, and then retwisted under tension. In these experiments the yarns were twisted with 4.4 turns per cm and placed under a tension of 20 g. The liquids used in this experiment are given in Table I with some of their physical properties. The height of the liquid in the yarn was observed at regular intervals up to about 24 hours or until the liquid had risen to a height of 12 cm. The experiments were performed in a room where the relative humidity and temperature were held at 68% and 70°F, respectively. The data obtained are plotted in Figure 5. The validity of Equation 4 in these liquid-yarn systems is shown by the linearity of the plots. The effect of gravity is not appreciable within the height range of about 12 cm, since the equilibrium height for this yarn is in the range of about two to three meters.

To study the effect of gravity, the wicking of Ucon 50-HB-55 was observed in cotton yarn held in vertical and horizontal positions. A cotton filling yarn from 8.5-oz gray sateen was mounted in a horizontal position under 20-g tension. It was brought into contact with a felt wick which stood in a beaker of colored Ucon 50-HB-55. The felt wick had been cleaned with Dreft solution followed by boiling alcohol and was dried in an oven before use. The height of the wick above the liquid was 2.2 cm. The wick was one inch long and 0.25 inch wide and was shown to have ample capacity for serving as a reservoir to the cotton yarn. The cotton yarn was placed in a trough cut lengthwise in the top of the felt wick. The distance traveled by the liquid in the yarn was measured from the point where the yarn emerged from the slot at the edge of the wick. Measurements were taken of the travel from both sides of the felt wick. The data plotted as distance traveled against the square root of the time (minutes) elapsed after the appearance of liquid in the yarn at the edge of the felt wick are shown in Figure 6, curve 1. This figure, curve 2, also shows a curve obtained with the same system where the yarn was in a vertical position. A comparison of the curves shows that for a short distance the rate of travel was the same in the vertical and horizontal yarns. The rate of travel in the vertical wick decreased more rapidly than in the horizontal wick, however, due to the effect of gravity in the former. Thus, when adequate provision is made for supplying liquid to the horizontal yarn, the only difference between horizontal and vertical capillary migration appears to result from the effect of gravity.

The vertical wicking of Ucon 50-HB-55 was also observed in a typical woolen yarn (filling yarns of Lebanon Flannel 425). In this case the natural twist was maintained and the yarns were placed under a tension of 20 g. The data obtained for three wicks are plotted in Figure 7. The

TABLE I
Properties of liquids used in wicking experiments

	Density[a] *(g/ml)*	*Surface tension*[a] *(dynes/cm)*	*Viscosity*[b] *(centistokes)*
Dibutyl butylphosphonate (DBBP)	.948	30.6	1.5 (approx 27°)
Ucon LB65	.96	33	17
Ucon 50-HB-55	.99	35	13
Diethylene glycol (DEG)	$1.12^{27°}$	$48^{25°}$	30
2-Anilino-ethanol (AE)	$1.11^{27°}$	$45^{27°}$	$49^{27°}$
Polyethylene glycol 400 (PEG 400)	$1.13^{27°}$	$49^{27°}$	87

[a]Density and surface tension values are for the liquids at 20° C. except where otherwise indicated by superscript.

[b]Viscosities are for liquids at 25° C except where otherwise indicated.

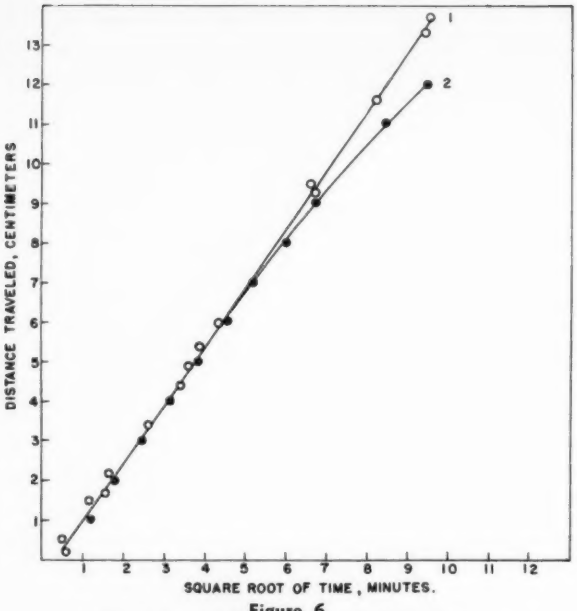

Figure 6
Comparison of horizontal and vertical wicking. Ucon 50-HB-55 in filling yarn from gray 8.5-oz carded sateen (cotton).
Curve 1: Horizontal wicking yarn 2.2 cm above liquid reservoir.
Curve 2: Vertical wicking from the point 2.2 cm above liquid reservoir.

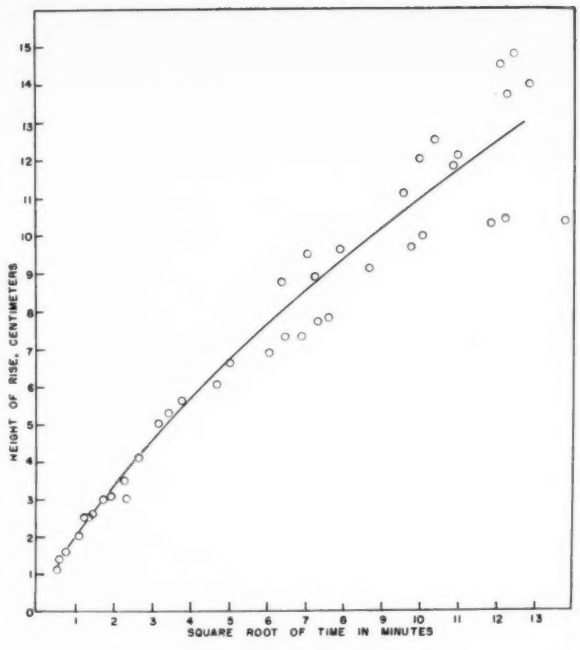

Figure 7

Vertical wicking in wool yarn. Rise of Ucon 50-HB-55 in filling yarn from Lebanon Flannel 425. Points show data from three runs. The curve shows the average of the three runs.

variability from yarn to yarn among replicates was no greater than expected for staple yarns of this type, although it was considerably greater than the variability of the cotton and nylon yarns examined. In contrast to the nylon yarns, the wool and cotton yarns did not give good straight line plots. As discussed above, this is due to the effect of gravity and indicates that the equilibrium height of rise in these yarns was much lower than in the filament yarns.

TRANSFER FROM YARN TO YARN——The next mode of migration studied was the transfer of liquid from yarn to yarn at points where the yarns cross. This type of transfer occurs repeatedly where liquid spreads in fabric to produce round or elliptical spots as shown in Figures 1 through 4. The experimental set-up consisted of a cotton filling yarn mounted under 20-g tension over supports approximately 33 cm apart. The supports consisted of glass rods five mm in diameter, fastened to a glass plate. Across this yarn a second yarn was placed, also under 20-g tension, and fastened directly to the glass plate instead of to supports. The effect produced was a cross of yarn. with each yarn bent slightly over the other. Neither yarn departed from a straight line by more than a few degrees (about 3°). These conditions were selected in order that the transfer of liquid from yarn to yarn could be studied conveniently, even though they do not exactly simulate the contacts found between cross-yarns in cloth, where the yarns are bent further around each other and make contact over a broader area. A drop of the colored test liquid was placed on one of the yarns, hereinafter called the feeder yarn, at a measured distance from the intersection of the two yarns and the movement of the liquid within the yarns was observed with a low power microscope. The data obtained in a typical experiment with one of the test liquids are shown in Figure 8. This figure shows the position of the test liquid, Ucon 50-HB-55, in each yarn at various times after application to the feeder yarn. It is apparent from Figure 8 that, after sufficient liquid has collected at the intersection of the crossed yarns to form a reservoir, the wicking rates in the two yarns are equal. In all of these experiments there was a brief period (too brief to be indicated in Figure 8) during which the rate of travel of liquid in the cross-yarn was abnormally high. This occurred while the liquid was accumulating in the cross-yarn at the cross point. In the experiment shown in Figure 8 the liquid appeared in the cross-yarn relatively soon after the liquid in the feeder yarn had passed the yarn intersection. In experiments with other liquids the liquid traveled further past the yarn intersection before it appeared in the cross yarn, but after it appeared in the cross-yarn it traveled in the three directions at approximately the same rate. It is concluded from these data that the yarn intersection acts as a new reservoir which feeds the branches equally.

MIGRATION IN INTERYARN SPACES——To study the movement of a liquid in a woven fabric where no interfiber (intrayarn) spaces exist, so that the liquid must move between the yarns, the wicking of diethyl sebacate was observed in a fabric woven of noncrenulated Saran monofilaments. The fabric was woven in a 3-up, 1-down twill pattern and the filling yarns were slightly larger than the warp yarns and were somewhat flattened, as shown in Figure 9. Referring to Figure 9, it can be seen that there are three different types of interyarn spaces. The A spaces are relatively large, since the warp yarns are separated at both ends by filling yarns. In the B and B′ spaces (which are equivalent but oppositely oriented), the warps are separated by a filling at one end but not at the other. The C spaces are smallest since the warps are separated at neither end by filling yarns. When the drop of liquid was first placed on the fabric it covered

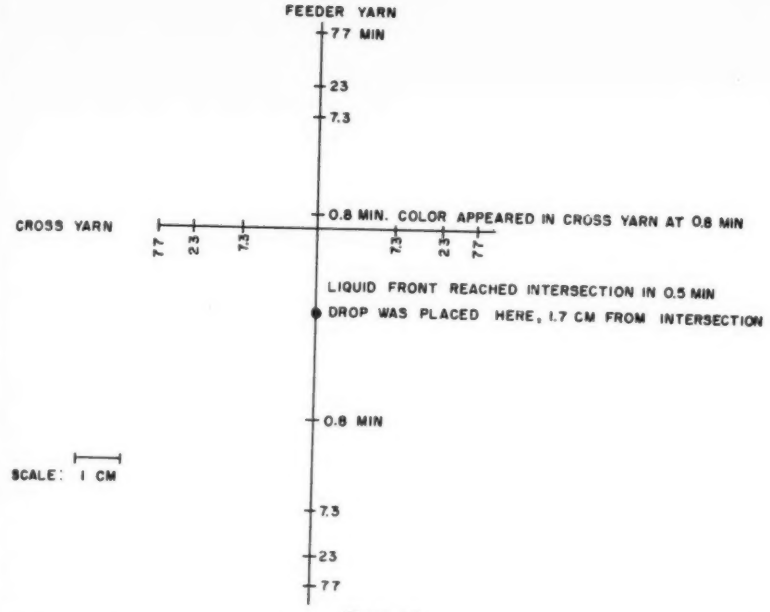

Figure 8

Diagram showing positions of liquid fronts in crossed cotton yarns at various times after applying a drop to one of the yarns. Numbers show the time in minutes required for the liquid to reach the positions indicated. Drop size: 3.7 mg. Liquid Ucon 50-HB-55. Yarn: Filling from 8.5-oz gray sateen.

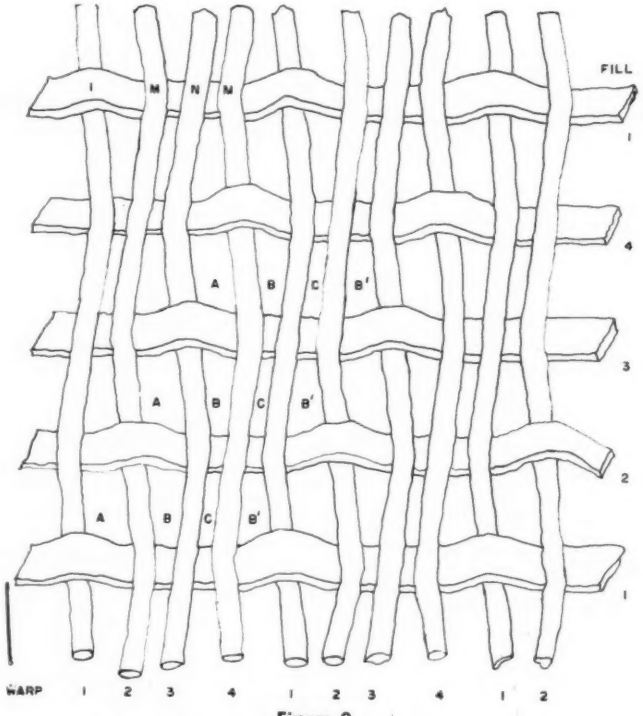

Figure 9

Diagram of Saran monofilament seat-cover fabric.

an area of 30 to 40 spaces. As it started to move, the first motion was from an A space near or on the edge of the wetted area to a B space or a C space. Liquid from B spaces moved into empty C spaces but not into empty A spaces. Thus the A and B spaces were eventually emptied and the C spaces held all the liquid. The liquid moved in the notch-shaped channels formed where the yarns cross over one another. These channels remained filled with liquid. After long periods of wicking, the C spaces tended to become empty and the liquid remained in the notch-shaped channels. The migration proceeds, as might be expected from the laws of capillarity, from larger to smaller spaces. The fact that the open troughs or notches serve as the paths of migration affords a possibility for assaying the relative importance of interyarn and interfiber (intrayarn) migration.

WICKING IN WOVEN FABRICS ——Wicking was next studied in strips of sateen fabric. The wicks consisted of strips of the fabric one inch wide and 12 or more inches long. Two kinds of strips, one cut along the warp and the other along the filling, were used and are designated as "warp vertical" and "filling vertical" strips, respectively. The wicks were mounted vertically by suspending them from one end and hanging a small weight on the other end, which served to sink the lower end of the strip into the liquid. The wicks were lowered into a reservoir containing the test liquid until a small length (at least 0.25 inch) of the bottom of the wick was submerged and the timing of the rise of liquid in the wick begun. The maximum height reached by the liquid in the wick was recorded at various times until successive readings, hours apart, showed negligible change. The data obtained using polyethylene glycol 400 are shown in Figure 10. It should be noted that after about three inches of rise of the liquid the effect of gravity can be seen. A large number of liquids were tested in this manner using strips of Lebanon flannel. The liquids mostly show identical wicking patterns, differing only in absolute wicking rate. In the case of moderately volatile liquids the apparent wicking rate decreased abnormally with time due to evaporation of the liquid from the wick.

The capillary channels leading from one face of a fabric to the other differ in their geometry from the capillary channels leading from one place to another in the plane of the fabric as a consequence of the construction of the fabric. This difference in geometry may cause corresponding differences in the capillary migration. Accordingly, a study was made of the transverse migration of liquids through fabrics. The rapidity with which many of the liquids used in these studies strike through a single layer of fabric makes accurate timing difficult if not impossible. A means of circumventing this diffi-

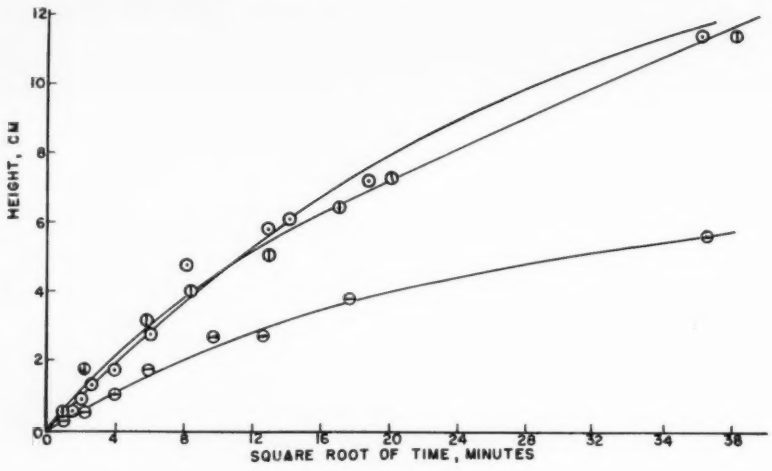

Figure 10
Rise of polyethylene glycol 400 in sateen.
Temperature: 23°C. Room humidity.
⊖ **Wick made of stack of one-inch-square swatches under two lbs pressure.**
⊕ **Strip of sateen one inch wide, 12 inches long, warp vertical.**
⊙ **Strip of sateen one inch wide, 12 inches long, filling vertical.**

culty appeared to be the use of multiple layers of fabric. An apparatus was constructed to hold a vertical stack consisting of many small swatches. The apparatus was designed so that the stack could be compressed in order to eliminate or minimize the effect of the surface nap. Thus, the capillary spaces between individual nap fibers were able to carry liquid by capillarity from layer to layer. The assembly was dipped vertically into the test liquid so that at least two cm of the stack was submerged. The movement of the liquid front was observed and the height of rise with time recorded. Data for one system are shown in Figure 10. A comparison of the curves shown in Figure 10 indicate that liquid migrates in the stack of swatches in the same manner as in the strips of fabric. Thus there is apparently no essential difference between capillary migration through the thickness of the fabric and capillary migration in the plane of the fabric.

SUMMARY

It has been confirmed that the capillary migration of representative organic liquids within yarns follows the $s^2 = kt$ relationship derivable from the Washburn equation. This relationship is also followed when the liquids move by capillarity in each of the three mutually perpendicular directions within a typical woven fabric, namely, warpwise, fillingwise, and through the thickness. The regions where one yarn crosses over another appear to act as new reservoirs, feeding each of the three branches that conduct liquid away from the junction. In fabrics woven from monofilaments, and presumably in fabrics of tightly twisted yarns, the notch-like troughs formed where the yarns cross each other can act as capillary channels causing and guiding liquid migration.

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General Calendar

AMERICAN COTTON MANUFACTURERS INSTITUTE
Mar 23-25 (12th Annual Meeting, Fontainebleau Hotel, Miami Beach, Fla)

AMERICAN SOCIETY FOR TESTING MATERIALS
June 26-July 1 (Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, NJ)

CHEMICAL EXPOSITION USA
Sept 13-15 (Statler Hilton Hotel, New York, NY)

FEDERATION OF BRITISH INDUSTRIES
June 10-26 (British Exhibition of Industry, Technology, Science and Culture—Coliseum, New York, NY)

INTERNATIONAL TEXTILE MACHINERY EXPOSITION
1962 (3rd Exposition, Hanover, Germany)

NATIONAL COTTON COUNCIL
Sept 28-29 (9th Chemical Finishing Conference, Statler Hotel, Washington, DC)

SOUTHERN TEXTILE EXPOSITION
Oct 3-7 (Greenville, SC)

SYNTHETIC ORGANIC CHEMICAL MANUFACTURERS ASSOCIATION
June 14, Sept 13, Oct 11, Dec 8 (Hotel Roosevelt, New York, NY)

TEXTILE OPERATING EXECUTIVES OF GEORGIA
Oct 22 (Harrison Hightower Bldg, Georgia Inst of Technology, Atlanta, Ga)

WORLD CONGRESS FOR MAN-MADE FIBERS
May 15-18, 1962 (2nd World Congress, London, England)

Future Papers

"A Scheme for Fiber Indentification with Emphasis on New Polyacrylic, Polyamide, Polyester and Cellulosic Fibers" by Robert S Merkel, Institute of Textile Technology

"Effect of Fabric Structure on the 'Wash-and-Wear' Properties of Viscose Lining Fabrics" by Arnold M Sookne and John F Krasny, Harris Research Laboratories, Inc

"Studies of Wrinkle-resistance Finishes for Cotton Fabrics. I. Release of Formaldehyde Vapors on Storage of Wrinkle-resistant Cotton Fabrics" by J David Reid, Richard L Arceneaux, Robert M Reinhardt, and James A Harris, Southern Regional Research Laboratory, USDA

"Studies of Wrinkle-resistance Finishes for Cotton Textiles. II. Effect of Storage on Properties of 'Wash-and-Wear' Cottons" by J David Reid, Robert M Reinhardt, Russell M H Kullman and Richard L Arceneaux, USDA

"A Study of the AATCC Accelerotor while Operating at Constant Power" by H P Briar, The Dow Chemical Co

"Cotton Fabric with Wet Wrinkle Recovery Produced with Formaldehyde without Excessive Strength Loss" by Wilson A Reeves, Rita M Perkins, and Leon H Chance, Southern Regional Research Laboratory, USDA

"Reaction of Cotton Cellulose with Epoxides in the Presence of Acid Catalysis" by John B McKelvey, Beverly G Weber, and Ruth R Benerito, Southern Regional Rsearch Laboratory, USDA

"FA Cotton Fabric: Preliminary Cost Study" by O J McMillan Jr, K M Decossas, A S Cooper Jr, C Hamalainen, A L Murphy and E F Pollard, Southern Regional Research Laboratory, USDA

"Replacing THPC in the APO-THPC Flame-resistant Finish for Textiles" by Thomas D Miles, Francis A Hoffman, and Alfred Merola, Textile, Clothing and Footwear Div, Quartermaster Research and Engineering Command, U S Army

LINT LIBERATION FROM COTTON FABRIC DURING LAUNDERING AND DRYING

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Lint liberation and cupriethylene diamine fluidity studies have been made of cotton fabrics and lints during various stages of home laundering. Results indicate that lint liberation is not solely a function of mechanical action, but is greatly effected by the addition of oxidizing bleaches. Chlorine-containing bleaches increase lint liberation to a greater extent than do peroxygen compounds.

Some correlation between lint liberation and cupriethylene fluidities are discussed. Lint derivation curves tend to increase sharply when a fluidity of nine to 12 rhes is attained.

Microscopic studies of cotton lints have been made. These studies showed that immature cotton fibers constitute in excess of 90% of lint liberated during early phases of laundering.

INTRODUCTION

THE textile chemist who has devoted his work and study strictly to the production, dyeing, finishing, etc, of cotton has conditioned himself to think of lint in only one sense; that is, in terms of the spinnable, useful fiber employed in the manufacture of cotton fabrics. But to the textile chemist in the appliance industry, lint has a completely different connotation. Instead of a useful commodity, lint means a useless waste which must be disposed of as cleanly and as effortlessly as possible. Unfortunately for the textile chemist in the appliance field, the subject of waste lint has been almost entirely neglected in scientific studies. Thus, while almost everyone is afflicted with tumbleweeds of lint in his home, no scientific investigation has been made to determine its nature, nor has anyone suggested a method to eliminate or reduce its formation.

The investigative work reported here has been done to establish the identity of household lint and to determine what factors affect its formation during the complete laundering process. Classically, lint has been regarded as the loose fiber abraded from the surface of fabrics during laundering and drying. There is undoubtedly a lot of merit in the classical concept, but to the authors this appeared only a partial answer. Were this concept fully valid, there should be approximately equal quantities of lint liberated during successive identical launderings of the same fabrics under identical conditions. This condition is not observed in actual laundering practice, especially when strong oxidizing agents are used to bleach the clothing.

EXPERIMENTAL PROCEDURES

DETERMINATION OF FIBER LENGTH DISTRIBUTION OF LINT ——To determine the physical nature and dimensions of lint fibers, the conventional lint filter of a tumbler dryer was modified by removing the wire mesh and substituting a frame mounting three microscope slides coated with raw linseed oil. The three slides were positioned to intersect a representative portion of the outflowing airstream from the dryer.

A nine-pound load of 56 × 48, 5.4 ounces per yard cotton sheeting, cut and sewn into towels measuring 20″ × 36″, was wet out in a 0.05% solution of nonionic surfactant. These towels were rinsed and spun out in a standard agitator washer to a residual moisture content of about 75%. They were then inserted into a tumbler dryer and dried for one hour; the outlet stack temperature thermostatically controlled to 160°F ± 5°F. The special lint collector was inserted during the last fifteen minutes of drying when, by previous observation, it was known that lint liberation was at a maximum. When drying was complete, the lint-coated slides were dismounted and measurement of lint fiber lengths were made by micrometric methods using a calibrated eyepiece micrometer at 100X.

THE EFFECT OF LAUNDERING ON LINTING POTENTIAL OF COTTON SHEETING——With the physical dimensions of lint established, we next investigated the linting properties of nine-pound loads of towels similar to those described above under household laundering conditions. These towels were laundered thirty times in our standard agitator machine using 17 gallons of soft water at 140°F ± 5%. A commercially available anionic detergent of the controlled suds variety was used at a level of 0.30% solution. The towels were agitated for ten minutes.

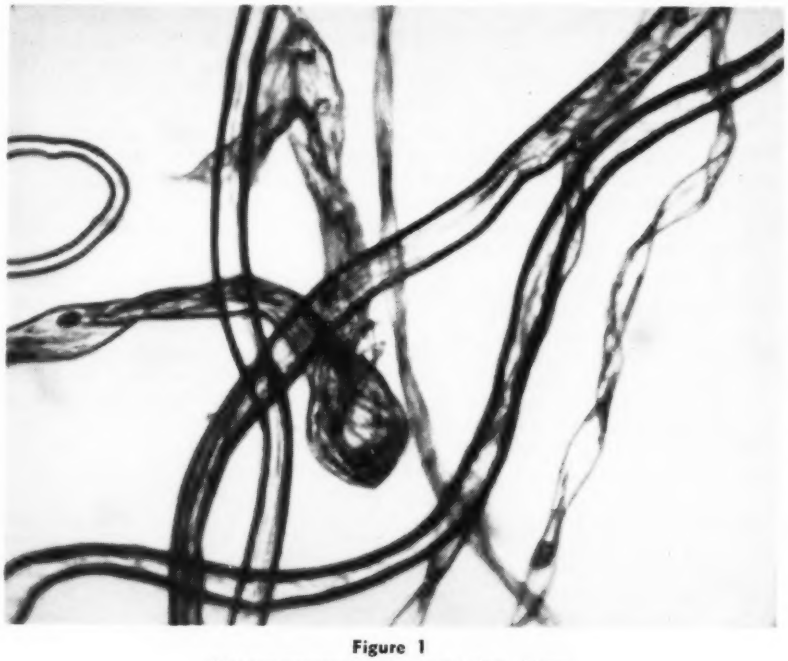

Figure 1
Photomicrograph of typical lint fibers

TABLE I

Sodium hypochlorite	200 ppm av [cl]
Sodium perborate	**180 ppm av [0]
Potassium monopersulate	* 40 ppm av [0]
Dichlorodimethylhydantoin	180 ppm av [cl]
Dichloroisocyanuric acid	180 ppm av [cl]

*Amount recommended by manufacturer.
**Previous unpublished work had shown no increase in lint using perborate at the 40 ppm av [0] level.

The bath was then drained and the test fabrics were extracted to about 75% residual moisture. The test fabrics were given three spray rinses during first spin out. Next, seventeen gallons of soft water at 100°F ± 5°F were used for rinsing. After rinsing for three minutes, the water was drained and the towels spun out to about 75% residual moisture. The washer-generated lint was extracted from its trap and dried in a tared weighing bottle. The towels were then tumbled in a dryer thermostatically controlled at 160°F ± 5°F. Lint generated during drying was trapped by a fine mesh screen intersecting the outflowing airstream. This lint was carefully collected after each drying, entered into tared weighing bottles and weighed.

To ascertain the effect of oxidizing agents on lint generation, the above experiment was repeated using 0.30% detergent solution plus the amount of bleaching agent recommended by the manufacturer of each of the materials shown in Table I.

The bleaching agent was added with the detergent in each of thirty or thirty-five launderings identical to those previously described. Lint collection was made for each laundering and drying, as described before. Quantities of lint were determined by weighing.

CUPRIETHYLENE DIAMINE FLUIDITIES OF LINT AND FABRIC——Cupriethylene diamine fluidities for lint and fabric were determined after each fifth wash and drying. TAPPI standard methods were employed in these determinations (*1*).

RESULTS AND DISCUSSION

Figure 2 shows the length distribution curve of cotton lint trapped on the linseed-oil-covered slides. As was expected, a great preponderance of lint fibers fall below 500 μ in length. The lower limit of fifteen microns is controlled by the major diameter of the fiber. In all cases, the maximum dimension of the lint fragment was measured, thus the diameter of the fiber becomes the lower limit of the determination. The maximum dimension observed, 11,000 microns, represents slightly less than one-half inch. The maximum length of lint fiber expected would be controlled by the staple length of the cotton.

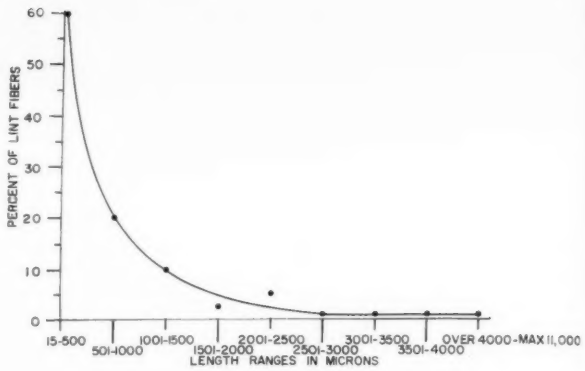

Figure 2
Fiber length distribution of cotton lint

Microscopic measurements of lint fiber lengths led to an unexpected observation. It was observed that a great majority of the lint fibers derived, especially during the early phases of laundering, were immature. Figure 1 shows a photomicrograph made of some typical lint fibers. Fiber maturity counts made by the caustic swelling technique consistantly showed maturity ratings of 5% or below. Lint fibers consistently dyed green by the Goldthwait differential dyeing technique. Thus lint generation might serve the useful purpose of removing nep-forming immature fibers.

The effect of using laundry detergent plus strong oxidizing agents for bleaches is shown on Figures 3-7. Figure 2 shows the lint generation realized by the use of detergent only in the wash bath. The high starting point of the graph probably indicates that this particular lot of cloth was improperly singed during mill processing or that it contained a high amount of immature fiber. The constant decrease in lint production reflects the lesser amount of immature and abraded fiber present in each successive laundering.

By far the most popular bleach employed in the modern home is sodium hypochlorite. Most investigations of the effects of hypochlorite on cotton cellulose have been conducted under conditions similar to mill usage procedures (*2*). The work of Furry and coworkers (*3*) closely approximates conditions encountered in home use of hypochlorites, wherein no antichlor is used to stop degradative action.

Figure 4 shows the marked effect on lint generation realized through the use of hypochlorite at the manufacturer's recommended use level, in conjunction with detergent in the laundry bath. The sharp upturn in lint production after fifteen launderings is directly attributable to the use of hypochlorite since all other conditions were identical to those when detergent alone was used in the wash bath.

In recent years there has been a shift toward the use of organic compounds containing chlorine for home laundry bleaches. The main sales feature for the organochlorines, since pricewise they are not competitive with hypochlorite, has been the "increased safety" realized through their use. Their availability in solid form has also added customer appeal. Typical of several organochlorine compounds currently available for home bleaching are dichlorodimethylhydantoin and dichloroisocyanuric acid. Figures 5 and 6, respectively, show the lint liberation attributable to the use of these products in a detergent bath. Again, use levels fall within the range specified by the manufacturer.

It is quickly apparent that the lint liberation rate of each of these compounds is much less than the rate for sodium hypochlorite. Again, fifteen appears to be the critical number of launderings to accomplish upturn of lint liberaton. The fact that the upward slopes of each of these curves is less than that for hypochlorite appears to validate the claim of "increased safety" for these products. Dichloroisocyanuric acid was the last bleach studied in these investigations. The fabrics used in the evaluation of this product came from a different lot of cloth. This fact accounts for the downward displacement of the lint curve when compared to other bleaching agents.

Peroxygen bleaches have long been recognized for their efficiency and safety by mill chemists. The availability of economical, high-volume peroxides, and the reduced damage encountered through their use, have forced many mills to rely completely

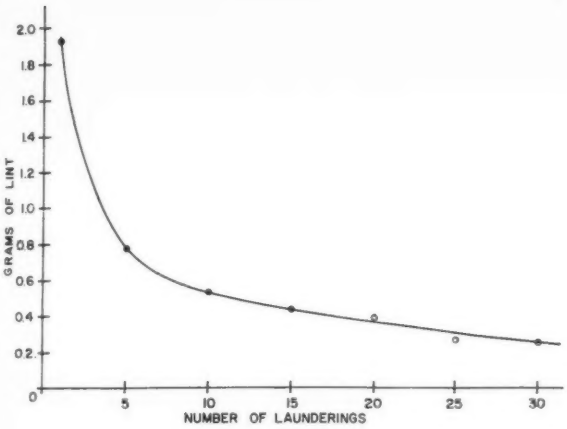

Figure 3
Lint generation—cotton cloth in 0.3% detergent solution

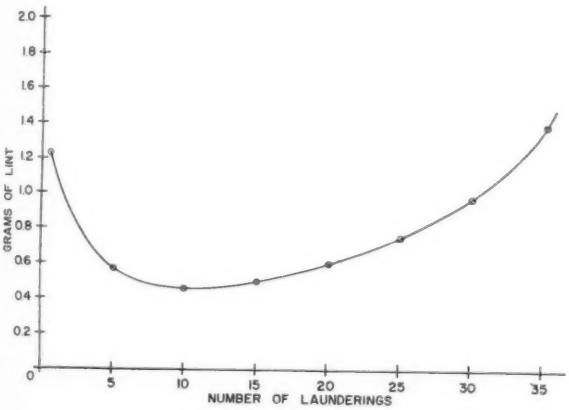

Figure 4
Lint generation—cotton cloth in 0.3% detergent solution plus NaOCl

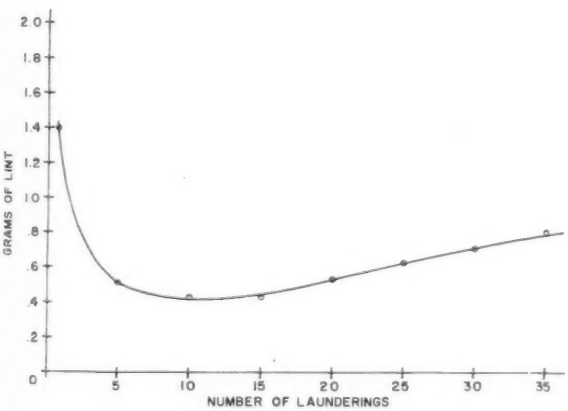

Figure 5
Lint generation—cotton cloth in 0.3% detergent solution plus DCDMH

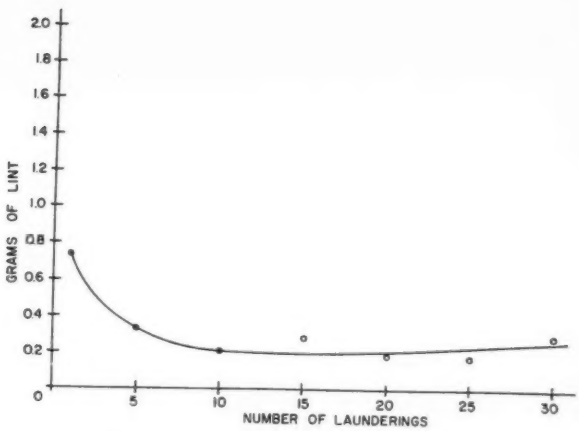

Figure 6
Lint generation—cotton cloth in 0.3% detergent solution plus dichloroisocyanuric acid

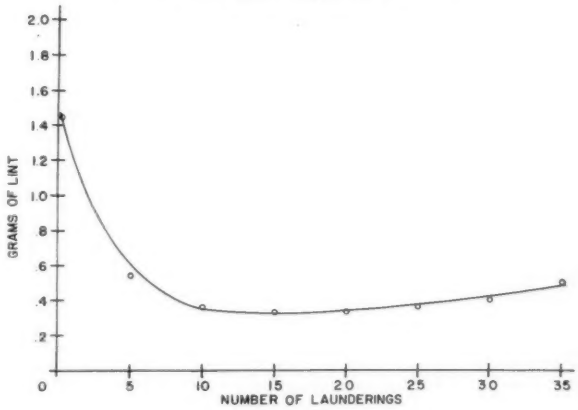

Figure 7
Lint generation—cotton cloth in 0.3% detergent solution plus sodium perborate

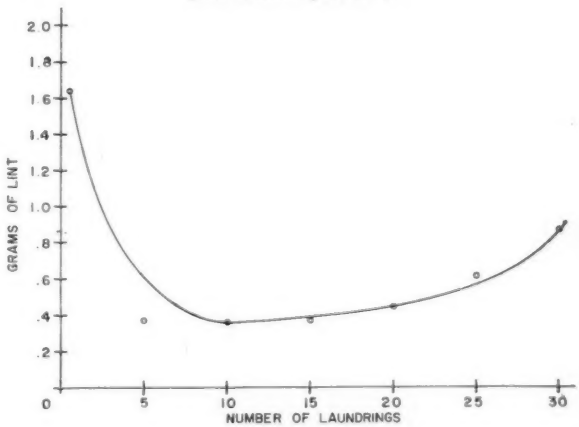

Figure 8
Lint generation—cotton cloth in 0.3% detergent solution plus potassium monopersulfate

on oxygen-containing bleaches. Unfortunately, two serious objections to home use of peroxygen compounds, for other than specialty bleaching, exist. First, high-volume hydrogen peroxide is too dangerous to be stored around a home and, secondly, dry peroxygen products, eg, sodium perborate, require too high temperatures for successful utilization under home laundry conditions. Nationally, home laundry is done at an average of about 125°F. One hundred forty degrees have been used in this series of experiments to assure at least partial liberation of oxygen from sodium perborate.

Lint generation is much reduced when sodium perborate replaces the chlorine-containing bleaches in a wash bath. Figure 7 shows this reduction. There is actually very little difference between this curve and that derived with detergent only. There is a very slight rise in lint production between twenty and thirty launderings, but this is not considered significant. Figure 8 shows the lint derivation curve for cotton washed with detergent and

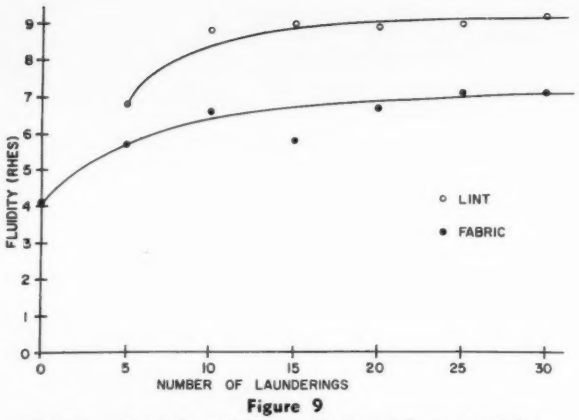

Figure 9

Fluidities of fabric and lint washed in detergent soluton

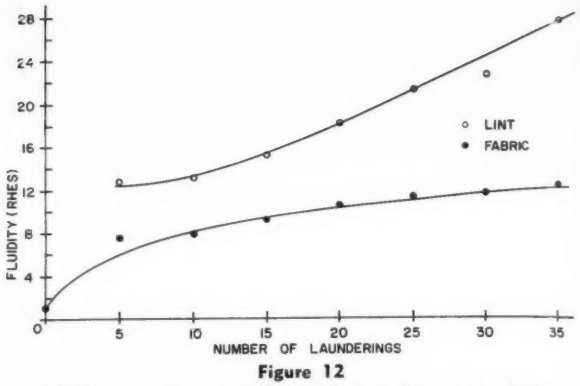

Figure 12

Fluidities of fabric and lint washed in detergent solution plus DCDMH

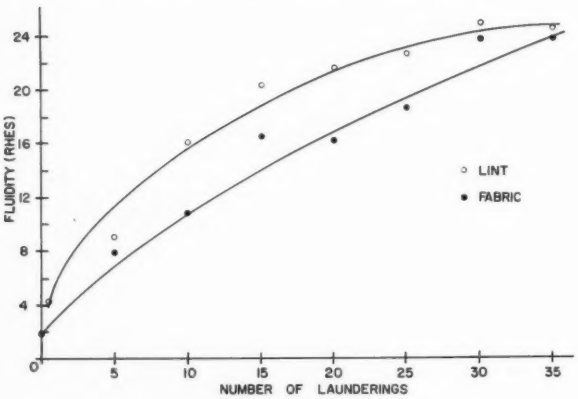

Figure 10

Fluidities of fabric and lint washed in detergent solution plus NaOCl

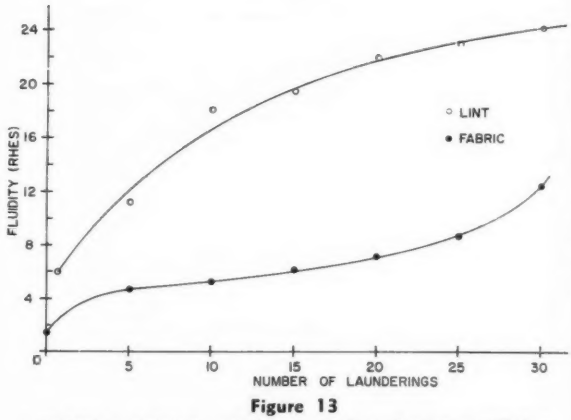

Figure 13

Fluidities of fabric and lint washed in detergent solution plus dichloroisocyanuric acid

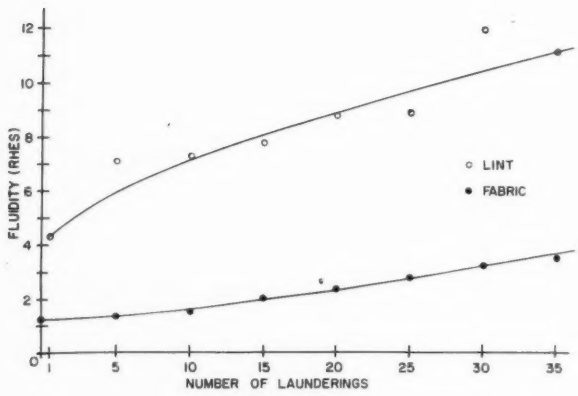

Figure 11

Fluidities of fabric and lint washed in detergent solution plus sodium perborate

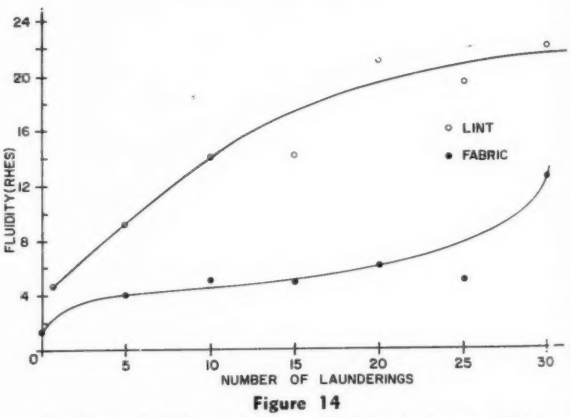

Figure 14

Fluidities of fabric and lint washed in detergent solution plus potassium monopersulfate

bleached with potassium monopersulfate. It is at once apparent that this peroxygen compound gives a curve quite similar to the organochlorine bleaches. This fact was at first puzzling to the authors; however, the unique ability of persulfate to oxidze the chloride ion to the hypochlorite ion is believed responsible. The water supply used in this series of experiments contains a measureable amount of $CaCl_2$ which, when softened, yields NaCl. Thus by the chloride-hypochlorite oxidation, persulfate generates hypochlorite *in situ*. This, we feel, is responsible for the similarity of the curve in Figure 8 with those in Figures 5 and 6. Work is now underway to verify this hypothesis.

RESULTS OF CUPRIETHYLENE DIAMINE FLUIDITY INVESTIGATION

Fluidity and tensile strength have been the basic methods of evaluation of damage done to cotton during laundering. Because of its greater simplicity, cupriethylene diamine flu-

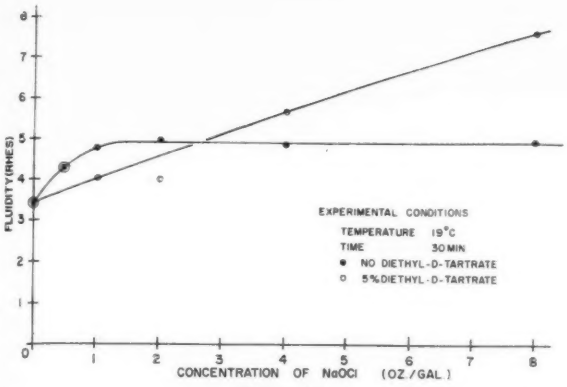

Figure 15
Buffering efficiency of diethyl-d-tartrate at room temperature

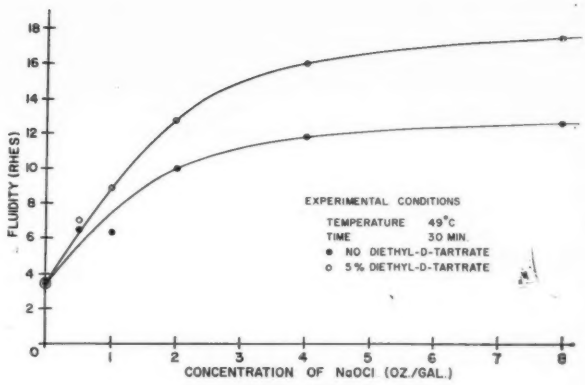

Figure 16
Buffering efficiency of diethyl-d-tartrate at 49°C

idities have been used in this series of experiments. Viscosity measurements were made according to TAPPI standard methods of fabric and lint after each fifth laundering, and their viscosities converted to fluidity. Results of these evaluations are shown in Figures 9-14.

Close study of the graphs showing fluidity and graphs showing lint generation shows a close correlation. In the case of launderings in which only detergent was used (Figure 9), the slight change in fluidity in thirty launderings agrees closely with the diminishing amount of lint released during the later launderings. The slight increase in fluidity reflects very little damage attributable to laundering with detergent only in the system. When sodium hypochlorite is added with the detergent (Figure 10), the great increase in fluidity correlates closely with the increase of lint capacity. The great rise in fluidity correlates closely with results obtained by Furry and coworkers (3).

The use of sodium perborate with the detergent (Figure 11) agrees also with its lint liberation curve and shows little or no fiber damage. The curves for dichlordimethylhydantoin, dichloroisocyanuric acid and potassium monopersulfate fall between the extremes of maximum and minimum damage represented by hypochlorite and detergent or detergent plus perborate respectively. This would be anticipated from a study of the lint liberation curves, provided there is good correlation between these curves and fluidity. This good correlation exists.

Close scrutiny of corresponding lint generation curves and fluidity curves shows an interesting phenomenon. Wherever the lint generation curves begin their upward turn, the fluidity of the fabric at that number of launderings is generally between nine and 12 rhes. The one major exception to this rule seems to be sodium perborate. The fabric at the point of change of slope of one lint curve has a fluidity of about three rhes. This fact seems to agree with our doubts about the significance of the upturn of the perborate lint curve.

It is interesting to speculate that when the range of nine to 12 rhes fluidity is reached, a critical time in the life of a cotton garment exists.

In every case, the lint fibers extracted from the cloth during drying runs higher in fluidity than do fibers extracted from the body of the cloth. Where bleaches are used in laundering, the rate of increase in fluidity is greater for lint fibers than for the cotton retained in the body of the fabric. The rate of increase is generally more pronounced with chlorine bleaches than with peroxygen bleaches.

Diethyl-d-tartrate has been advocated as an inhibitor of damage done to cotton during bleaching with with sodium hypochlorite (4). To determine if this product has any inhibiting influence, two experiments were conducted. In these experiments cotton fabric was immersed for 30 minutes in 5% solutions of diethyl-d-tartrate containing various amounts of sodium hypochlorite. Temperatures were controlled at 70°F in one series of experiments and at 120°F in the other. Distilled water was used throughout. Results are shown in Figures 15 and 16.

At 70°F (19°C), Figure 15, diethyl-d-tartrate appears to exert a protective action in realistic ranges of hypochlorite concentration. This protection disappears, indeed damage appears to be accelerated, when the concentration of 5.25% hypochlorite exceeds three ounces per gallon. This situation could occur in home laundering in localized areas within the washer when pure 5.25% hypochlorite is poured directly onto clothing. At 120°F (49°C), any protective action exerted by the diethyl-d-tartrate disappears. This is shown in Figure 16. Under conditions of this experiment, the tartrate ester appears to enhance the damage done by the hypochlorite. It is indeed unfortunate that most housewives prefer to bleach in the wash cycles, ie, at about 125°F.

CONCLUSIONS

The theory that mechanical action alone is responsible for lint formation during laundering and drying of cotton is not completely valid. The use of strong oxidants as bleaching agents, especially oxidants containing chlorine, increases materially the lint production of a given cotton fabric. Sodium perborate included with detergent in a wash formula produces little or no increase in lint over that encountered with detergent alone. A close correlation exists between lint generation of a cotton fabric and the cupriethylene diamine fluidity of that fabric. Fluidity of nine to 12 rhes appears to be a critical point in the life of a cotton garment because, between these values, lint liberation begins to increase. Diethyl-d-tartrate appears to offer some protection against chlorine bleach damage at 70°F in realistic concentrations of chlorine. This protection disappears at 120°F.

In excess of ninety percent of lint fibers obtained from cotton cloth possess fiber lengths less than 1,500 microns. Maturity counts made during laundering of newer cotton fabrics show that lints are made up of about 95% immature fiber.

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(2) American Association of Textile Chemists and Colorists. "Literature Survey of Textile B'eaching," *Am Dyestuff Reptr* 39, 663, 703, 739, 782, 820 (1950).
(3) Furry, M. *et al*, "Evaluating the Effectiveness of Fluorescent Whiteners and Oxidizing Bleaches on Cotton", *ibid* 48, No. 8, p 59-73 (1959).
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Abstracts

Vat Dyeing of Cotton Fabric by Pigmentation Methods

Fox, M R, and Mawson, J F, *J Soc Dyers Col* 76, 73-7, Feb, 1960

The use of vat pigment padding for cellulosic fabrics has increased considerably during the last 25 years. What is now generally termed the *pad-jig* process was originally developed as a means of obtaining well-penetrated vat dyeings on tightly constructed materials. There is now no doubt whatever that the pad-jig process gives results far superior to those obtained by leuco jig dyeing, and it can be stated generally that a properly handled pad-jig application more nearly approaches the quality of a woven yarn-dyed fabric than that obtained from other forms of vat piece-dyeing, with the possible exception of certain pale shades produced by the leuco ester or the vat-acid process. The pad-jig process also produces a more satisfactory surface appearance and greater coverage of constructional faults and differences in fiber affinity.

In addition, the pigment padding process has become even more important as the basis of the more successful high-speed continuous vat-dyeing systems, eg, the pad-steam sequence and the pigment-pad Standfast molten metal machine reduction sequence.

The authors stress the importance of uniform and efficient preparation of the goods at all stages; maximum absorbency should be the objective.

If the cloth is properly prepared, it may be pigment-padded without an assistant; but as an insurance against faulty preparation and in order to increase pick-up and promote penetration, a padding assistant is generally used. The two types most commonly employed are highly sulfonated oils and alkylated naphthalene sulfonates. An antifoam agent may be required, in addition.

The authors describe the physical properties which a vat dye must possess if it is to be used for pigment padding. All vat dye dispersions should be passed through a fine wire-mesh screen, to remove large particles. The fine particle size must be maintained constantly. The stability of the dispersion may be destroyed by high bath temperatures, and is similarly affected by unsuitable padding assistants.

In certain continuous dyeing sequences it is advantageous, and frequently necessary, to dry the pigmented fabric before reduction. Under adverse drying conditions there is a tendency for migration of the pigment to occur. It is frequently possible to effect a marked improvement with regard to migration faults by making suitable additions to the padding liquor, eg, common salt, Glauber's salt, sodium bisulfite, sodium acetate, and various types of common thickeners, but there are risks associated with this practice. Inorganic salts, for example, may lead to severe pigment aggregation and poor penetration, even if the surface appearance of the dyeing is satisfactory. Sodium alginate, when properly prepared, is probably the most suitable thickening. Migration Inhibitor V, described as "an organic polyelectrolyte of anionic character" is stated to be very efficient in reducing the migration fault.

Nine references to the literature are cited.

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Physical Characteristics—Their Effect on "Wash-and-Wear" Fabrics

Hamburger, W J, Papers AATT, *Modern Textiles* 41, 51-4, March, 1960

The writer points out that there are fundamentals involved in "wash-and-wear" of which we still have very little understanding. He doubts that the perfect "wash-and-wear" fabric will be developed until these areas are thoroughly probed.

Wrinkle, crease, and surface deformation are all influenced by the ability or lack of ability of fibers, yarns, and fabrics to deform. Among the various factors involved are fiber swelling and shrinkage, yarn size and twist, thread spacing, filament denier, and the type of weave.

A textile structure is the only sheet-like material which is light, permeable to air and moisture vapor, tough, flexible and strong. Such a unique structure must of course have complexity. In attempting to maintain on it a constant surface appearance, the writer says, we are not dealing with simple phenomena. There is, of necessity, a resistance to or propensity for bending, and these factors are extremely important in "wash-and-wear" fabrics. Here it is important to understand how a fabric bends, or, in other words, the direction of wrinkles relative to warp and filling.

In laboratory tests a sharp fold is generally made at a right angle to either the warp or the filling. From such a fold the recovery angle or crease angle is determined. But in fact, the writer asks, is this the way the fabric would normally wrinkle if left to its own devices? Obviously, wrinkling will occur where the bending resistance is least; this may be at the intersections of the yarns or in a bias direction. This bias bending, as it influences wrinkling and creasing, is a condition which has been overlooked, he says. He suggests that maybe this is the mechanism to be studied in future, in order to develop a perfect "wash-and-wear" fabric.

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Carpet Tufting—Technology and Principles of Manufacture

Roux, R A, *Can Textile J* 77, 53-6, Mar 4, 1960

The author gives a brief history of the growth of the tufted fabrics industry. Back in the 1930s, candlewick bedspreads, made by hand in many homes in the Southern states, were very popular. Later this new industry was taken over by the mills, where the same technique was used to produce rugs, mats, and other articles. In 1950 the first broad rayon tufted rug appeared, and in 1954 the first precision tufting machine producing 45-inch-width carpet was installed. Since that time the growth of the industry has been very rapid, due, the author says, to the various advantages offered by tufted carpets in respect to color, texture, patterning, productivity and price.

There are three constituents in a tufted carpet: the pile, the backing, and the coating. The pile yarns used mostly are said to be acetate, Acrilan, cotton, nylon, rayon, wool, and blends of these. The backing is usually jute. The manufacturing processes are described in much detail.

The finishing of tufted carpets generally comprises two or three processes. Rubber latex is the most common coating compound. The principal function of the latex is to lock the pile of the carpet to the

(*continued on page 79*)

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Niagara Frontier Section——

A NEW REACTANT RESIN FOR "WASH-AND-WEAR" FINISHING OF COTTON FABRICS*

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The performance characteristics of present-day cotton finishing systems are reviewed, and compared with the ideal performance that could be expected within the limitations of the covalent crosslinking theory. Each system is seen to provide a different compromise of properties, none of which approaches ideal performance. A new finishing system is described which, though still not ideal, is said to provide a better total performance than does any other existing system.

INTRODUCTION

THE extremely rapid growth of "wash-and-wear" (W & W) cotton fabrics has created tremendous demands upon all facets of the textile industry. Nowhere has this been more evident than in the area of finishing resins, upon which, as everyone recognizes, the W & W properties of cotton largely depend. Considerable progress in this area has already been made in the four short years since W & W cotton surged into prominence.

The triazone resins have been developed and have found large-scale commercial application, particularly in shirtings. Several nonnitrogenous resin systems have been developed, and used to a limited extent. Blends of these newer resins with established ones have been investigated, and in some instances have been used. Improvements have been made in melamine-based resins. Particularly in the last two years, several studies have been published, reappraising the established resins in comparison with newer ones, in the light of the more critical demands of W & W finishing.

However this may be, no one pretends that the ultimate in finishing resins has yet been achieved. Every commercially available cotton finishing resin has performance drawbacks, even when applied and processed on fabric under optimum conditions. Many highly adequate finishes are possible from the wide selection of finishing resins, but every finish is a compromise of many desirable properties with some undesirable ones. The object of this paper is to review the characteristics of the presently available resin systems, and to present performance and processing data on a new resin system, Resloom* E-63, which we believe represents a major improvement over present systems. We will attempt to describe how Resloom E-63 yields a combination of desirable fabric properties not possible to achieve with any other resin or blend of resins.

*Presented before the Niagara Frontier Section on April 22, 1960

IDEAL "WASH-AND-WEAR" REQUIREMENTS

Before considering the performance of the various resins, it is desirable to set forth the ideal performance characteristics of the ultimate W & W cotton fabric, against which the resin systems we discuss may be compared. These ideal properties are listed in Table I. Our object in preparing Table I is to provide a common standard for the realistic appraisal of various resin systems, and not to set forth an arbitrary standard. The requirements are those which in our experience have generally been considered as optimum. It is recognized that some other properties, and different requirements, might also be included.

A brief discussion of Table I is appropriate here. Some of these properties can be achieved with present resins, and some cannot be achieved with any existing resin. All are desirable, and most, but not all, are necessary for a fabric that would meet all consumer requirements. Requirements A, B, and C can be achieved at present, as can reasonable approximations of G, H, I and J. Some resins perform adequately by K-Q, but there is no finish which can

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TABLE I

Property requirements for ideal "wash-and-wear" cotton fabric

Code	*Property*	*Level of performance*
A	Dry wrinkle recovery	= that obtainable with DMEU
B	Wet wrinkle recovery	= or > that obtainable with DMEU
C	"Wash-and-wear"	5, by AATCC 88-1958, 3A and 4A
D	Tensile strength	= or > untreated
E	Tear strength	= or > untreated
F	Abrasion resistance	= or > untreated
G	Odor, odor development	none
H	Discoloration, hot chlorine	none
I	Discoloration, wash	none
J	Discoloration, 400 F scorch	= untreated
K	A, B, & C after 50 home launderings (HL)	= original
L	A, B, & C after 20 comm laundering (CL)	= original
M	Dimensional stability to 50 HLs	less than 1% shrinkage
N	Dimensional stability to 20 CLs	less than 1% shrinkage
O	Chlorine retention	none
P	Chlorine damage—50 HLs	none
Q	Chlorine damage—20 CLs	none
R	D, E, & F after 50 HLs	= or > untreated
S	D, E, & F after 20 CLs	= or > untreated

TABLE II

Performance of various resin systems relative to ideal "wash-and-wear" requirements

Code	Resin System ⟶ / Property	DMEU	Triazine	Triazone	Epoxy acetal	Halo-hydrin	Resloom E-63	Ideal crosslinker
A	Dry wrinkle recovery	++	+	+	+	−−	++	++
B	Wet wrinkle recovery	++	+	+	+	++	++	++
C	"Wash-and-wear"	++	++	+	+	−	++	++
D	Tensile strength	−	−	−	−−	−	−	−
E	Tear strength	−	−	−	−−	+	−	−
F	Abrasion resistance	−	−	−	−−	+	−	−
G	Odor, odor development	+	+	−−	++	++	+	++
H	Discoloration, chlorine	++	−−	++	++	++	++	++
I	Discoloration, wash	++	+	+	++	++	++	++
J	Discoloration, 400°F scorch	++	++	−−	?	++	++	++
K	A, B and C after 50 HLs	+	+	−	+	−−	+	++
L	A, B, and C after 20 CLs	−−	−	−−	+	−−	−−	++
M	Dimensional stability to 50 HLs	++	++	+	++	−−	++	++
N	Dimensional stability to 20 CLs	−−	−	−−	++	−−	−−	++
O	Chlorine retention	−	−	−	++	++	−	++
P	Chlorine damage—50 HLs	+	+	++	++	++	++	++
Q	Chlorine damage—20 CLs	−	+	++	++	++	+	++
R	D, E, and F after 50 HLs	−	−	−	−−	−	−	−
S	D, E, and F after 20 CLs	−	−	−	−−	−	−	−

meet all of these requirements (A-C, G-Q).

Properties D, E, F and R, S are not even remote possibilities with any finish known today. If the covalent crosslinking theory is correct, and there is abundant evidence (though perhaps no classic proof) that it is, then strength loss is a fixed, proportional consequence of the very properties we require for W & W. A finish yielding these properties will require a new technology rather than improvement in simple crosslinking agents.

Fortunately, these characteristics are or can be adequate with today's treatments, and provided the other properties are met, an ideal W & W cotton fabric is possible without them. The consumer, unlike the finisher, cares not what the strength of the fabric *was*, before treatment, as long as it is adequate in the fabric he buys, and remains adequate for a reasonable use period.

EXISTING RESIN SYSTEMS

Considerable data on the performance of individual resins and comparisons between them have been published recently in a number of excellent studies (*3-15, 23, 25, 27-31*). Other studies on particular properties, such as chlorine damage and W & W (*1, 2, 16-19, 21, 22, 24, 26, 33*), with a variety of resins, have appeared in the literature. In addition, present resin-finishing practice has in most instances separated wheat from chaff, and is also a valuable criterion for the appraisal of resin systems. Utilizing these sources, various resin systems have been rated against the criteria set forth in Table I. This analysis is recorded in Table II, using the following symbols: ++ = optimum performance, + = adequate performance by today's standards, − = barely adequate, minimum performance, −− = inadequate performance. The resin systems are coded as follows: DMEU———dimethylol cyclic ethylene urea; Triazine———triazine, methylated methylol melamine; Triazone———triazone, triazone-urea formaldehyde mixtures; Epoxy Acetal———diepoxide and diacetal resins; and Halohyrin———highly alkaline, caustic swollen halohydrin treatment. Resloom E-63 has been included here for ease of comparison, although its general chemical nature and the performance data supporting these ratings are most conveniently reported in a later portion of this paper. The last column, labelled "Ideal Crosslinker", records the properties which would be achieved with an ideal finishing agent, within the confines of present crosslinking theory.

In an analysis of such broad scope, it is difficult to generalize on the performance of a type of resin without the danger of working some inequity on a particular product of that type. Further, with the necessary choice of a small number (in this case, four) of performance levels, small but significant differences may be obscured or emphasized unduly. Another difficulty arises where a variety of test procedures have been used to evaluate a particular property.

An attempt has been made in the subsequent discussion of each resin to minimize these problems by: 1) presenting the properties of the best product within a class, and indicating where major variations exist; 2) pointing out those areas where the tabular rating is disproportionate, and 3) presenting the means by which tabular ratings were evolved for those properties normally evaluated by widely variant techniques. Table II should therefore be considered in the light of the ensuing discussions, and is not intended to stand alone.

DIMETHYLOL CYCLIC ETHYLENE UREA (DMEU)———DMEU is the most widely used of the cotton W & W finishing resins, largely due to its combination of high efficiency, good durability under many use con-

ditions, and low price. With the exception of formaldehyde and some urea-formaldehyde adducts, which are totally inadequate for other reasons, DMEU is more efficient and will produce a higher ultimate wrinkle recovery than any other cotton reactant or resin.

A 300° dry and 280° wet wrinkle recovery can be achieved by a DMEU treatment of an 80-square print cloth of 100-120° untreated wrinkle recovery (*31*), and this level of wrinkle recovery insures an AATCC W & W rating of 5. Accordingly, it is rated optimum for A, B, and C. Depending on the untreated fabric strength, the proportionate strength loss may or may not allow an adequate finished strength with ultimate (A, B, C) performance. A W & W rating of 5 can be achieved at less than ultimate wrinkle recovery, perhaps 270-280° dry (*16*), so some compromise is generally made. All fabrics considered, the balance is struck, for a good W & W finish, with minimum adequate strength, hence the rating given for D, E, and F.

Properly cured and afterwashed DMEU-treated cotton presents no practical odor (G) problem. Under less desirable processing conditions, and particularly in summer months, it can give rise to formaldehyde odor. DMEU finishes do not yellow with chlorine (H) under any conditions, and straight DMEU-catalyst treatments are actually better than untreated cotton in resistance to wash discoloration (I), although additives normally used may contribute to poorer performance. DMEU-treated cottons are also highly resistant to scorch discoloration (J).

The durability of the properties of DMEU-treated cottons is largely dependent upon processing conditions, particularly firm curing and alkaline afterwashing (*26*). Under these conditions, good but not perfect durability of properties to home laundering results. Wrinkle recovery losses of 30-40° and a W & W rating loss of 1 are about the maximum to be expected for the useful life of the garment (K). Commercial laundering, however (white washes, with chlorine bleach and acid sour), causes severe hydrolysis of the finish, resulting in an essentially complete loss of the properties imparted by the DMEU treatment, and therefore completely inadequate performance by criterion L.

Dimensional stability in the practical sense may be imparted to cotton either by mechanical preshrinkage or by resin treatment. If cotton fabric is preshrunk prior to the curing step, the fabric will be adequate regardless of the resin used. However, the yardage to be gained by avoiding preshrinkage and relying on the finish for stability offers an economic incentive not to be ignored, and it is by this criterion that resins should be judged. As the amount of resin required for dimensional stability is far less than that required for W & W, the slight loss of properties due to home laundering of DMEU-treated cotton has no influence on stability, so that DMEU is optimum in regard to "M". However, progressive shrinkage will occur as a result of hydrolysis of the finish on commercial laundering, and DMEU is inadequate here (N).

Criterion O pertains only to the retention of chlorine by a finish, and excludes the influence of such retention on other properties. As the total chlorine problem has assumed such importance in this field, and as every finish that retains chlorine suffers in some respect because of this, the very presence of retained chlorine must be regarded as a disadvantage. "P" and "Q" are particularly difficult to evaluate. The least that can be said of many of the tests available is that they are certainly accelerated. There is sufficient evidence for us to support the opinion of other workers (*2, 3, 22*) that some are abusive and totally unrealistic. For the sake of simplicity, we will present without argument in this section, the basis for the ratings given in Table II, and treat this subject more thoroughly in the experimental section.

Optimally DMEU-treated fabric, to our knowledge, does not show chlorine damage under home-laundering conditions, so that on this basis alone it must be considered adequate. On the other hand, its susceptibility to chlorine damage does increase upon home laundering, as measured by an accelerated test, AATCC 92-1958 (*35*), so that the increased likelihood of damage, however small this may be practically, must be considered less than optimum for "P". With commercial laundering, DMEU very soon shows total loss by AATCC method 92-1958. Urea-formaldehyde resins, which are known to damage with chlorine, show total loss by this test *before washing*. Only false logic leads from these data to the conclusion that DMEU is inadequate or borderline (Q), but two other factors contribute to this poor rating. Some (but not all) studies have shown strength loss with DMEU on commercial laundering, and resin-use patterns indicate that such a result is at least feared.

Apart from strength loss due to chlorine damage, DMEU-treated fabric strength decreases at a very slow rate with washing. Largely because original strength properties were considered barely adequate, the same rating is given for "R" and "S".

In summary, DMEU is the most efficient and economical finishing agent for a quality W & W cotton finish. It has the minor and easily controlled formaldehyde odor propensity characteristic of all N-methylol compounds. Its only severe disadvantage is poor resistance to acid hydrolysis, which gives rise to its poor durability and chlorine-resistance properties under commercial laundering conditions. Because of this, it is not considered entirely adequate for white goods or very high-quality finishes, although it is the most widely used of the W & W finishing agents.

TRIAZINES, METHYLATED METHYLOL MELAMINES —— The melamines were the first quality resins made available for cotton finishing, and were largely responsible for the development of the "crush-resistant" finish that in effect spawned W & W cottons. The unmodified melamines are inferior to other resins in their chlorine yellowing characteristic, and also in resistance to chlorine damage. Although extensively used, particularly on prints and colored goods, they cannot compete with other resins in high-quality W & W finishing. Improved melamine-based resins have been reported (*3, 34*), and at least one is commercially available. The ratings for this class are based on these latter products which we will label triazine for lack of a better term.

The efficiency and ultimate wrinkle recovery (A, B) of the triazine is slightly lower than with DMEU (*4*) but still high enough to allow excellent W & W (C). Wrinkle recovery is an instance where the difference is probably less than a full unit on our rating scale. As regards "D" "E" and "F", some authors (*4, 28, 30*) have concluded that, at equivalent wrinkle recovery, melamine-based resins cause slightly less strength loss than DMEU, under identical application conditions. However, when each resin is cured at its optimum temperature (290-300°F for DMEU, 330-340°F for triazine), as is necessary

for both to avoid serious problems, this difference does not exist, or is insignificant. Triazines, like DMEU, are compromised on minimum strength.

Again as with DMEU, a formaldehyde odor problem largely controllable by proper processing exists with the triazine (G).

Criterion H is a problem which the melamine class of resins has all to itself. The traditional melamine resins yellow with chlorine under a variety of normal use conditions, and are totally inadequate for use where there is a reasonable possibility that the treated fabric will come in contact with chlorine bleach. The modified melamines are much better when optimally processed, and do not yellow under many of the conditions where unmodified melamine resins do. They will yellow under some conditions, which may not be "normal," but are encountered particularly on white fabrics. In addition, the resistance to yellowing is dependent on an optimum cure, which is generally not obtained commercially, and in use, severe yellowing problems have resulted and continue to result with the triazines, hence an inadequate rating for "H".

Wash discoloration, soil pickup, and soil retention are influenced to a far greater extent by softeners and other formulation additives than by the finishing resin (*17*). However, differences may be noted between resin finishes containing no additives. Compared with DMEU, triazine finishes discolor during washing under some conditions, particularly in hard water areas. This property is given a lower rating (I), although it may have little significance on the basis of total formulations. The excellent durability of the triazine yields essentially the same home laundering results discussed for DMEU, and the same rating for "K", "M" and "P". It retains more chlorine than DMEU, but is rated the same for "O". The triazine is significantly more resistant to acid hydrolysis, however, and therefore is rated higher on "L", "N" and "Q". Almost total loss of finish results after 20 commercial washes as it does with DMEU, and so "L" and "N" should be rated inadequate, but the higher rating is given to indicate its better performance in the first few washes.

The triazine has been rated adequate for resistance to chlorine damage on commercial washing (Q), because, by our own and published data (*3*), it does not lose appreciable strength under these conditions. This may indeed be due to compensation of strength loss by the strength regain due to crosslink hydrolysis, but it is still practical performance. It is felt that the intermediate strength losses (30-70%) shown by AATCC 92-1958 on commercially washed triazine-treated fabric shows more an improper application of an accelerated test to yield an unrealistic result, than it reflects upon triazine performance. Unmodified melamines are inadequate by "L", "N", "O", "P", and "Q". The same considerations for "R" and "S" with DMEU apply to the triazine.

In summary, modified melamine resins are effective agents for producing quality W & W cotton finishes. Slightly less efficient than DMEU, they offer somewhat better resistance to hydrolysis and retention of properties in commercial laundering. Their resistance to chlorine damage in commercial laundering is good and probably commercially acceptable. A major disadvantage which perhaps prevents their wider use in white goods and shirtings is their susceptibility to discoloration, particularly chlorine yellowing.

TRIAZONES ——— The triazones are the most successful of the resins whose development was directly stimulated by the demand for a better W & W finish for white goods. Almost solely by virtue of their ability to show low chlorine damage by any accelerated test, they have achieved widespread use in those areas, for example, shirtings, where the danger of chlorine damage is greatest. The insurance they appear to provide in this respect against customer complaint has stimulated their use in spite of a large number of relatively poor performance characteristics.

The proprietary triazone resins are generally based on 1,3-dimethylol-5-ethyl tetrahyrotriazinone, but most of them are mixtures of this material with urea-formaldehyde resin (*30*). For the purpose of this paper, triazone is used in a generic sense, including the pure and mixed products.

Pure triazone is less efficient for wrinkle recovery and W & W than DMEU or triazine, although mixtures with UF or other resins improves the efficiency, so that the triazone class may be rated adequate for "A", "B", and "C". The wrinkle recovery strength loss relationship compares with that of DMEU, and so strength properties are rated the same.

Triazones have a serious odor problem (G). Decomposition of their cyclic structure liberates a highly offensive, oderiferous amine, and the cyclic structure is quite sensitive to decomposition under many fabric conditions normally encountered. Great pains are taken by every finisher using triazones to minimize this problem, but the danger cannot be completely eliminated. The triazones also possess the relatively minor formaldehyde odor propensity characteristic of N-methylol compounds. No discoloration is encountered with chlorine bleach (H), and wash discoloration is not a problem (I). Heat discoloration (J) is another severe problem inherent with triazones. As long as the triazone remains on the fabric, the fabric will discolor when pressed or ironed at elevated temperatures. The problem is intensified above 350°F, for example, in home ironing (iron surface temperature, cotton setting, approx 400°F). It is theorized that this again is due to release of free amine, which causes alkaline yellowing of the cellulose at these temperatures.

The durability of triazone finishes is poor even to home laundering conditions (K), although part of this may be due to the presence of UF resin. Very rapid loss of properties occurs in commercial laundering (L). Dimensional stability (M, N) is also worse than with DMEU or triazine. Triazones retain considerably more chlorine than DMEU, and are rated the same as DMEU, as criterion O is defined.

Resistance to chlorine damage, even under commercial laundering conditions, is outstanding with the triazones. Triazone-processed fabrics seldom show more than 20% loss by AATCC 92-1958, even after acid sour (commercial, but no chlorine bleach) washing. These properties (P, Q) are therefore optimum.

Data have been published (*3*) which conflict with this conclusion, indicating by actual commercial laundering test that triazone-treated fabrics do suffer substantial strength loss. Further investigation would be required to determine if this result is characteristic of all of the commercial triazone resins, and if so, to what cause this could be attributed. It is entirely possible, for example, that this result is due to the presence of urea formaldehyde.

In summary, triazones are only moderately efficient cotton-finishing agents, with a number of perform-

ance disadvantages not possessed by other resin types. They have one outstanding property, resistance to chlorine damage, which is of great importance, particularly in the W & W shirting market.

DIEPOXIDE AND DIACETAL REACTANTS———These materials represent an approach to cotton finishing quite different chemically from that employed with the more traditional finishing agents. Depending on epoxide or acetal rather than N-methylol functionality, they provide a means for producing desirable properties on cotton without the introduction of nitrogen, thereby eliminating many of the inherent disadvantages of the N-methylol reactants. From a theoretical point of view, they depend on the same mechanisms, and function in the same manner to produce wrinkle recovery and W & W effects, as do the N-methylol compounds; that is, they crosslink cellulose chains through difunctional reaction with cellulose hydroxyls.

They have not, as yet, achieved the dominant position in the industry that their inherent advantages would allow, because of other properties that have not as yet been sufficiently improved. Blends of these materials with other resins (eg, epoxy plus triazone, epoxy plus DMEU) have been and are being used, the properties of such finishes again being compromises which do not realize the potential of these nonnitrogenous reactants.

The major failing of the epoxy resins is their very low efficiency in producing wrinkle recovery and W & W, both in relation to strength loss and economics. Major problems appear to be the high-molecular-weight molecule required to prevent volatility under reaction conditions, and reactivity with water. In addition, the strong acidic catalyst and the high (20%) solids applications required with the epoxy type to produce adequate wrinkle recovery often results in excessive strength loss. Although similar problems exist with the acetals, high wrinkle recoveries on cotton with pentaerythritol diacetal have been reported (*13*), and good results with a "milder" catalyst ($AlCl_3+MgCl_2$, stronger than normal N-methylol catalysts) have also been described (*14*). The ratings given for "A"-"F" therefore may not be completely accurate for certain of the acetals, or for the most recently announced diepoxide (*27*). It will be noted in the subsequent ratings that these materials are exceptional by most of the criteria (G-Q) applied. By virtue of their different chemistry (the epoxy gives a true ether linkage, as opposed to the partial amino analog of an acetal with the N-methylol compounds), the finish is stable even to acid hydrolysis. Significant retention of W & W and wrinkle recovery after commercial white laundering is found with these finishes———a performance no known N-methylol compound can match. Excellent dimensional stability and absolutely no chlorine retention or damage are further advantages.

NaOH PLUS HALOHYDRIN——Considerable interest has been generated by another approach to cotton finishing, that of reacting a halohydrin, such as 1,3-dichloropropanol-2, with cotton preswollen in alkali. Theoretical consideration of this technique has not appeared in the literature, but it appears from the results produced by this system that intermolecular crosslinking of cellulose chains is not involved.

The remarkable feature of this system is that it will produce wet wrinkle recovery at least as high as that obtainable with other systems, with no increase in dry wrinkle recovery. It therefore gives the unusual result of inadequate dry wrinkle recovery (A), optimum wet wrinkle recovery (B), and inadequate W & W (C) (*33*).

The only published data relating to strength properties of this system (*30*) shows only moderate losses, which is at variance with our experience indicating substantial loss. This is arbitrarily compromised in Table II by equating tensile performance with the other resins, and indicating better tear and abrasion performance by virtue of the peculiar lubricating prperty imparted by the treatment.

Although performance by criteria "G"-"J" and "O"-"Q" is optimum, the system is inadequate for "K"-"N". In this instance durability is not the influencing factor. It fails "K" and "L" because it was inadequate originally for "A" and "C". It apparently does not impart dimensional stability, thereby being inadequate for "M" and "N".

Although this is a new approach which could, possibly, provide a route to the ideal finishing agent, at its present stage it appears to offer little potential for W & W finishing of cotton.

IDEAL CROSSLINKER———The performance that could be expected from an ideal cellulose reactant has been included in Table II for purposes of comparison with the presently available systems, none of which is entirely adequate. This set of properties has two things to recommend it: 1) it can be achieved, theoretically at least, within the scope of cellulose crosslinking theory; and 2) it represents ideal performance to the W & W consumer. This, then, is an extremely desirable goal lying within the realm of possibility. The absolute aim, of course, would be to gain all this with a strength increase, rather than a decrease, which is a far more distant goal, if not an impossible one.

BLENDS———Various blends of resin systems have found commercial application, and have been reported in the literature. Two of note are epoxy plus DMEU (*9*) and triazone plus DMEU (*7*). Both are compromises, according to the published data on their performance. The epoxy resin sacrifices some of its excellent durability and chlorine resistance to become adequate in W & W and wrinkle recovery by blending with DMEU. In the other blend, DMEU sacrifices efficiency, color, odor, and durability to improve chlorine damage resistance by blending with triazone. The blending approach does have practical and commercial significance, yielding as it does a different balance of advantages and disadvantages. It is obviously not the route to an ideal crosslinking agent.

RESLOOM E-63———Resloom E-63 is a product recently made available in commerical quantities for the quality W & W finishing of cotton. Chemically, it is a water solution of the methylol derivative of a heterocyclic, nitrogen-containing material. Although similar in function and reactivity to available finishing resins of the N-methylol type, it is different in composition and in performance from all presently available resin types.

In performance it approximates the excellent efficiency and odor characteristics of DMEU, with superior chlorine-resistance properties. It is adequate in resistance to chlorine damage after both home and commercial laundering, and capable of competing with triazones in this respect. For white goods applications, its high efficiency, freedom from all types of discoloration, excellent odor

characteristics, and resistance to chlorine damage are not equalled by any other material available.

Although its properties obviously indicate its use alone for a quality W & W cotton finish, it is also a superior material for the improvement of epoxy and triazone resin performance through blending. In the following section, processing technology and performance data for Resloom E-63 are discussed.

TABLE III

Application properties of Resloom E-63 and DMEU

Resin	Solids applied	Wrinkle recovery W+F (O) Original	Wrinkle recovery W+F (O) One wash	Chlorine damage Percent loss after one wash	"Wash-and-wear" (AATCC 88-1958 4A)
Resloom E-63	3.1	195	186	12	2.1
	5.1	222	211	9	3.7
	7.3	238	237	4	4.2
	10.5	249	243	4	5.0
DMEU	2.9	189	188	81	—
	4.8	219	208	72	3.8
	6.8	239	235	32	3.7
	9.9	246	244	25	4.7

EXPERIMENTAL

The following experiments were carried out to assess the performance of Resloom E-63. The experiments were controlled by identical treatment with known resin systems, to eliminate the difficulty of interpreting results where other influencing variables (fabric, application, processing equipment, etc) are present.

The relative performance of Resloom E-63 and DMEU for wrinkle recovery, durability, and chlorine retention was determined in the following manner. The two materials were applied to an 84 × 76 pure finish light cotton print cloth at four solids levels, using 0.25% Catalyst AC* on total bath with E-63, and 1% Catalyst AC on total bath with DMEU. The fabrics were wet out, padded to 80% wet pickup, framed to original dimensions, dried three minutes at 220°F, and cured three minutes at 310°F. Solids applied were calculated from wet pickup data, and wrinkle recovery was determined before and after the wash described below, by the Monsanto test (AATCC 66-1956). Chlorine retention was determined by AATCC 92-1958, after this wash, which consists of a two-hour cycle, at the boil with live steam, at pH 10 with soda ash and detergent in a reversing, wash wheel machine, with no load, followed by a five-minute and then a ten-minute rinse. W & W was determined by AATCC 88-1958 4A (35), using the three-dimensional standards (32). The results are recorded in Table III.

The wrinkle recovery imparted by the two treatments is essentially identical, although wet pickup variation resulted in the application of slightly more Resloom E-63 at the various levels. A plot of wrinkle recovery as a function of solids applied yields nearly identical curves. This result has been obtained repeatedly in the laboratory and in extensive mill evaluation. We have concluded that, for all practical purposes, Resloom E-63 is equivalent in efficiency to DMEU.

The durability of wrinkle recovery with Resloom E-63 to harsh alkaline washing, and therefore home laundering, is indicated by this data to be at least equivalent to DMEU. W & W performance is also equivalent to DMEU. Again, this result has been confirmed by mill evaluation to DMEU. No difference has been found between Resloom E-63 and DMEU in the wrinkle recovery-strength relationship, so that, unlike any of the other available resin systems, Resloom E-63 matches the performance of DMEU by criteria A-F in Table II.

In order to present this analysis in the sequence employed in the earlier section, the chlorine damage data in Table III will be discussed later. Also, in the interest of brevity, performance by some of the more easily evaluated criteria are summarized rather than presented in full detail. Odor characteristics of Resloom E-63-treated cotton have been evaluated under a variety of conditions, including hot aqueous alkali and the 100° F, 100% RH, 24-hour, sealed jar test. No amine odor has ever been detected, and only a faint formaldehyde odor is obtained under the harshest conditions. Under proper processing conditions, Resloom E-63 is entirely adequate by criterion G, and is at least as good as DMEU or triazine.

It will not yellow in hot, full strength, household bleach (H), gives rise to no wash discoloration by itself or with additives adequate in this property (I), and discolors no more than untreated cotton upon 400°F scorching (J), and thereby performs optimally by these criteria. As indicated by the data in Table III, good but not perfect alkaline wash retention makes Resloom E-63 highly adequate for "K", and optimum for "M". As its strength properties are the same as those of the DMEU and triazine, it is rated the same as these materials by "R" and "S". Commercial white laundering gradually hydrolyzes the Resloom E-63 finish, as it does DMEU, triazine, and triazone finishes, so that it is rated the same as these materials by criteria L and N. The remaining criteria pertain to chlorine performance, and are deserving of full discussion due to the complexity of their evaluation.

CHLORINE RETENTION AND DAMAGE——Resloom E-63 finishes do retain small amounts of chlorine, as is indicated under criterion O. It will be noted in Table III that, with harsh alkaline washing followed by the AATCC accelerated test, Resloom E-63 finishes show substantially no loss. Under these conditions, the DMEU finishes show substantial chlorine damage, which result is in agreement with published data (26).

Even after six hours of alkaline washing at the boil, Resloom E-63-treated cottons have consistently given less than 10% loss by AATCC 92-1958. It is accordingly rated optimum for this property after home laundering (P), similar to the triazone-resin types.

The complexity of, and resultant confusion about, the evaluation of chlorine resistance to commercial laundering, makes conclusions based on one evaluation technique rather tenuous. Accordingly, we have relied on three different methods for evaluating this property. The first method consists of a series of commercial, acid sour washes without chlorine, followed by the accelerated chlorine damage test (AATCC 92-1958). An evaluation of this type was run as follows.

Four Resloom E-63-treated fabrics from four separate plant trials, together with three competitive finishes, were given five consecutive washes in a commercial machine, each wash consisting of four suds cycles at 120°F ard six rinses at 120 and 100°F, using regular commercial detergents and laundry aids, but no chlorine, and souring to pH 4 with

*Reg TM, Monsanto Chem Co

TABLE IV

Tensile strength loss due to AATCC 92-1959 of cotton fabric finished with various agents after five commercial washes without chlorine

Fabric code	Finishing agent	Percent loss, AATCC 92-1958
1	Resloom E-63	13
2	"	11
3	"	24
4	"	48
5	Triazine	52
6	Triazone-epoxy	11
7	Triazine	14

TABLE V

Tensile strength loss due to AATCC 92-1958 of finished shirting fabric after washing and various acid sour treatments

Percent Zn SiF_6 in acid sour bath	pH of acid sour bath	Percent tensile loss AATCC 92-1958	
		Triazone—W&W shirting finish	Resloom E-63
0	7.0	14	12
0.001	6.4	18	6
0.005	4.0	18	11
0.010	3.6	19	20
0.020	3.4	20	23

zinc silico fluoride in the final rinse of each wash. The fabrics were then subjected to AATCC 92-1958, yielding the results given in Table IV.

It will be seen that three of the Resloom E-63 samples gave losses in the range of 20% or less, as did two of the three competitive finishes. The high strength loss of samples 4 and 5 may reflect inadequate processing rather than an inherent property of the finishes, or some other variable, but do serve to indicate that they may show damage by this test. Further experience has indicated that while Resloom E-63 will perform well by this evaluation technique, it does not do so consistently, or in a predictable manner.

It is difficult to assess the significance of this result. Data have appeared in the literature indicating that this technique does not provide a valid measure of the fabric strength to be expected after commercial white (with chlorine) washing (3). We would also question its validity, on the grounds of the major differences between commercial washes with and without chlorine in other fabric properties. Specifically, acid sour washes without chlorine produce only moderate losses in wrinkle recovery and "wash-and-wear" values, whereas the "white" commercial washes cause substantial or complete loss of these properties with nitrogenous finishes, indicating much more severe degradation of the finish and removal of potential chlorine-retaining bodies.

A second laboratory technique was developed specifically to evaluate the effect on chlorine damage of acid sour pH, perhaps the most critical variable in commercial laundering of resin-finished cotton fabrics. In an experiment of this type, a broadcloth shirting finished in the mill with Resloom E-63 was compared with a commercial "wash-and-wear" shirting of the same fabric finished with a triazone resin. These fabrics were first washed according to AATCC 91-1958 IV (35), and samples of each were immersed for 15 minutes in solutions of 0, 0.001, 0.005, 0.010, and 0.020% zinc silico fluoride at 120°F, using an 8:1 liquor/fabric ratio. The samples were removed without rinsing, press dried at 300°F, aged one day and then subjected to the AATCC 92-1958 accelerated chlorine damage test. The results are recorded in Table V.

Both finishes show excellent resistance to chlorine damage even under the harshest souring conditions. Taken as precise measurements, the data indicate slightly greater damage with increasing sour concentration, as would be expected, and slightly better resistance to damage with Resloom E-63 in the normal pH range (AIL recommended pH-5.0). The poor precision of AATCC 92-1958 (± 10%) does not allow such an analysis, however, so that it may only be concluded that both finishes are highly resistant to damage by this test even under extreme acid sour conditions, and that Resloom E-63 is at least equivalent in this respect to a commercial white shirting finish.

A third method for evaluation of this property is to determine fabric strength before and after extended white washing in commercial laundries. This method is far more expensive and time consuming than laboratory techniques, and introduces many possible variations, particularly in procedure, that cannot be controlled from one experiment to the next. However, it is the most realistic and reliable technique for assessing the true performance of a textile finish, evaluating this performance, as it does, under actual use conditions.

Two separate experiments of this type were run at different times, on the fabrics previously evaluated by commercial laundering without chlorine (Table IV), and those evaluated by the variable acid sour technique (Table V). Also included in the second experiment were laboratory treatments at 5% solids of Resloom E-63 and DMEU on an 80-square print cloth. In each experiment, approximately yard-square samples were submitted to a large local commercial laundry. The samples were subjected to ten of the laundry's regular complete white wash cycles, including pressing after each wash, care being taken that all samples were processed together at all times. The ten-wash-cycle test was selected on the basis of previous experience indicating that "wash-and-wear" and wrinkle-recovery properties imparted by these finishes were totally removed in ten washes, which result was confirmed in this work. Tensile strength determinations were run on both warp and filling before and after washing, and used to calculate the resultant strength changes listed in Table VI.

In experiment A, no strength losses showing slight gains, and three of the occured, with most of the fabrics

TABLE VI

Tensile strength change of finished cotton fabrics after ten commercial white (with chlorine) launderings

Experiment and fabric Code	Process	Finishing agent	Percent tensile strength change
A 1	mill	Resloom E-63	+ 21
2	"	"	+ 17
3	"	"	0
4	"	"	+ 16
5	"	triazine	+ 8
6	"	triazone-epoxy	+ 4
7	"	triazine	+ 8
B 1	mill	Resloom E-63	— 5
2	"	triazone	— 11
3	laboratory	Resloom E-63	+ 5
4	"	DMEU	— 22

Resloom E-63 finishes exhibiting a moderate strength increase after 10 commercial white launderings. In the second experiment, the strength of both the commercial and laboratory-processed Resloom E-63 samples was virtually unchanged by washing, while the DMEU had a moderate but significant loss, and the commercial white shirting finish (triazone) gave intermediate results with a barely significant loss.

These strength changes are the result of several factors, including 1) the strength gain resulting from removal of the finish, 2) the strength loss due to chlorine damage, 3) the strength loss due to mechanical abrasion, and 4) the strength loss due to hydrolysis of cellulose in the wash or acid sour. It is therefore understandable that *no correlation is found between the results of an accelerated chlorine damage test* (Table IV) *and the actual performance of a fabric in extended chlorine laundering* (Table VI).

This final evaluation indicates that Resloom E-63 finishes do not show appreciable strength losses on extended white commercial laundering. These results are in good qualitative agreement on comparable finishes with published data (3) for 20 commercial launderings. Determination of the pH of Resloom E-63 fabrics after the commercial laundering, by AATCC 81-1954 (35), gave values ranging from 3.8 to 4.6, thus indicating the laundering procedure to be particularly harsh with regard to acid souring. The conclusion that Resloom E-63 finishes are substantially resistant to strength damage on commercial laundering thereby appears valid, and a highly adequate rating is given for criterion Q.

PROCESSING

The properties previously described for Resloom E-63 are dependent upon proper formulation and processing. For the best results, it is essential that the softener, wetting agent, bluing, and other additives used must also be adequate in their performance characteristics.

It has been found that those additives presently used for quality finishes may be used with Resloom E-63 with no more difficulty than with nitrogenous resin systems. Thus, excellent results with Resloom E-63 are usually achieved the first time by starting with the additive formulation already developed by the mill.

Two specific processing requirements must be met in order to obtain optimum performance with Resloom E-63. One is a firm cure, and the other is an afterwash or neutralization step after the cure. Although highly adequate properties can be achieved with a borderline cure and no afterwash, both of these operations are essential for optimum resistance to chlorine, and durability of properties. The purpose of the afterwash is to remove or neutralize residual catalyst, which, if allowed to remain on the fabric, will cause a gradual loss of chlorine resistance. Simple alkaline padding, an aqueous rinse, or a light washing, are equally effective.

A firm cure is obtained if actual fabric temperature reaches 300°F or above for a short period. The variable heat transfer characteristics of commercial curing equipment do not allow recommendation of any one curing cycle. Optimum cures have been achieved with a laboratory cure cycle of 30 seconds at 310°F, and with mill cycles ranging from 90 seconds at 330°F to 50-60 seconds at 360 to 400°F. Operating cycles in this range do not guarantee an optimum cure where heat transfer is poor; in one trial a less than optimum cure was obtained at a 70-second, 360°F cycle, and measurement showed that actual fabric temperature did not go above 270°F.

Catalyst AC is recommended for use with Resloom E-63, at 0.25 to 0.5% on total formulation, and yields optimum performance under the cure cycles discussed above with no attendant disadvantages. If optimum results are not achieved with 0.5% Catalyst AC, an inadequate cure cycle is being used, and higher concentrations will not produce better results. Other catalysts may be used with Resloom E-63, but are generally less desirable. Magnesium chloride is too sluggish, and requires higher temperatures. Zinc nitrate is very effective, but requires close control to avoid fabric damage, and a thorough afterwash to prevent scorch discoloration.

SUMMARY

For the purpose of comparison of existing cotton-finishing systems, the concept of the ideal crosslinker, or more specifically the ideal combination of performance characteristics that could be expected for a finishing agent within the confines of the crosslinking theory, has been presented. Although each finishing system possesses one or more singular advantages, and each presents a unique combination of properties, not one approaches the performance of the "ideal crosslinker".

A new finishing system, like many of its forebears nitrogenous in character, is introduced, and performance and processing data are presented for this system. Although it also falls short of ideal performance, it is seen to possess a unique and more desirable combination of properties than was previously available by any means.

ACKNOWLEDGMENT

The author expresses his sincere appreciation to those who, through their experimental efforts, professional judgment, and advice, contributed to this paper. S H Foster deserves particular mention, as do E H Rossin and G O Langlais, who were largely responsible for the extensive field evaluation.

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Theme: "New Fibers, New Blends, New Fabrics

1960 AATCC CONVENTION

October 6-7-8 • Hotel Sheraton, Philadelphia, Pa

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The Executive Committee for the 1960 National Convention held its most recent meeting on May 16, 1960 to discuss progress and finalize plans for what is expected to be one of the largest and most successful events in AATCC history.

S Graeme Turnbull (extreme right), E I duPont de Nemours & Co, Inc, chairman, Technical Program Committee, discusses plans developed by his Committee with other members of the Convention Executive Committee. L to r: Thomas H Hart, Hart Products Corp, chairman, Reception Committee; A E Raimo, John Campbell and Co, co-chairman, Registration Committee; Charles N Kuzma Jr, Amalgamated Chemical Corp, chairman, Reservations Committee; Frederick V Traut, Globe Dye Works Co, Convention chairman; and Ernst W Empting, Verona Dyestuffs, Inc, co-chairman, Registration Committee

Looking over the 1960 Exhibit prospectus are (seated, l to r): M H Klein, Sandoz, Inc, chairman, Exhibits Committee; George P Paine, executive secretary, AATCC; Frederick V Traut, Globe Dye Works Co, Convention chairman; William H Bertolet III, Laurel Soap Mfg Co, Inc, Convention co-chairman. To the rear are Donald W Robinson (left), Para-Chem, Inc, chairman, Finance Committee, and William S Sollenberger, American Viscose Corp, AATCC vice president representing the Central Atlantic Region

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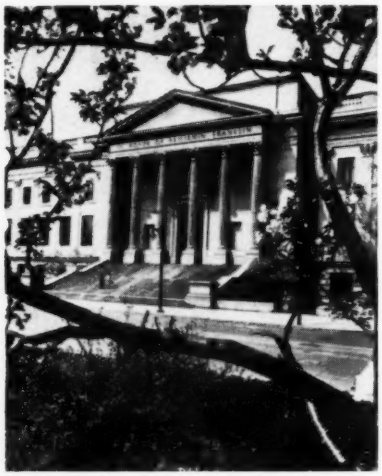

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You have recently received an invitation from the Exhibits Committee to be represented at your Association's National Convention at the Sheraton Hotel in Philadelphia, October 6-8, 1960.

I hope you will give every consideration to this invitation through which your organization and AATCC can mutually benefit. We are not asking any company to put on an exhibit simply to make a financial contribution to AATCC. We believe that exhibits are good advertising, but we would like to see you use this opportunity to present to the assembled Convention a visual presentation of technical and scientific value supplementing the Technical Program.

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The Executive Committee of AATCC's national body has gone on record with a statement in which it joins with the Exhibits Committee of the 1960 Convention in extending a cordial invitation to your organization and I quote:

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Future Papers

The following list is comprised of titles of papers submitted to date for publication in future issues of the Proceedings. Authors and Technical Program Chairmen are requested to examine this list and call our attention to any omissions.

"Fluorescent Brighteners and Bluing Agents in Wool Processing"—Delaware Valley Section

"Procinyl Dyestuffs—Novel Disperse Reactive Dyestuffs for Nylon"—Raymond Thornton, Arnold, Hoffman & Co, Inc

"Development of the Standfast Patent Continuous Molten-metal Vat Dyeing Processes"—A Ogden, Standfast Dyers & Printers Ltd

"The Permachem System—Total Environmental Control"—Walter W Burbank, Permachem Corp

"The Dyeing of Vinal Staple"—Walter H Hindle, Walter H Hindle, Inc

"Lightfastness of Dyestuffs on Textiles"—C H A Schmitt, Sandoz, Inc

AATCC Calendar

COUNCIL, COUNCIL COMMITTEES, RESEARCH COMMITTEES
Sept 8-9 (Atlanta, Ga); Sept 8—Council Committees and Research Committees; Sept 9 (AM)—ECR, TCR; Sept 9 (PM)—Council
Nov 17-18 (New York, NY); Nov 17—Council Committees and Research Committees; Nov 18 (AM)—ECR, TCR; Nov 18 (PM)—Council

NATIONAL CONVENTIONS
Oct 6-8, 1960 (Sheraton Hotel, Philadelphia, Pa); Sept 28-30, 1961 (Buffalo, NY); 1962 (Southern Region); 1963—Boston; 1964—New York; 1965—Chicago

DELAWARE VALLEY SECTION
Sept 16 (Reading, Pa); Nov 4, Dec 9 (Philadelphia, Pa)

HUDSON-MOHAWK SECTION
June 24 (Annual Outing)

METROPOLITAN SECTION
June 17 (Outing—North Jersey Country Club, Wayne, NJ)

MID-WEST SECTION
June 18 (Outing, Cerami's Island View Resort on Browns Lake, Burlington, Wis)

NORTHERN NEW ENGLAND SECTION
Sept 9 (Outing—Wachusett Country Club, West Boylston, Mass); Oct 21 (Hotel 128, Dedham, Mass—"Customer Service"—Arthur Swenson, J P Stevens & Co, Inc, and P J Fynn, J C Penney Co); Dec 9 (Colonial Country Club, Lynnfield, Mass—"Present-day Economic Outlook in Textiles"—William I Kent, Kent Mfg Co); Jan 20 (Hotel 128, Dedham, Mass—Symposium on "Mechanical and Chemical Finishing of Textile Fabrics"—John J McDonald, Lowell Technological Inst, D D Gagliardi, Gagliardi Research Corp, and Werner von Bergen, J P Stevens & Co, Inc)

PACIFIC SOUTHWEST SECTION
July 16 (picnic); Sept 24-25 (Outing—Apple Valley, Calif); Nov 18 (Rodger Young Auditorium, Los Angeles, Calif); Dec 10 (dance)

PIEDMONT SECTION
Sept 23-24 (Hotel Charlotte, Charlotte, NC); Jan 21 (Poinsett Hotel, Greenville, SC); April 2 (Washington Duke Hotel, Durham, NC); June 9-10, 1961 (Outing—Grove Park Inn, Asheville, NC); Sept 23, 1961 (Hotel Charlotte, Charlotte, NC)

RHODE ISLAND SECTION
June 24 (Outing—Metacomet Country Club); Sept 23 (Management Night); Oct 28 (Providence Engineering Society); Dec 2 (Annual Meeting—Johnson's Hummocks)

SOUTH CENTRAL SECTION
Sept 17, Dec 9 (Hotel Patten, Chattanooga, Tenn)

SOUTHEASTERN SECTION
Sept 10, Dec 3 (Atlanta Athletic Club, Atlanta, Ga)

WESTERN NEW ENGLAND SECTION
Sept 23 (Blake's Restaurant, Springfield, Mass); Oct 21 (Annual Meeting, Rapp's Restaurant, Shelton, Conn); Dec 2 (Rapp's Restaurant, Shelton, Conn)

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Bipinchandra R Shukla (S)

Lowell Technological Institute
Wen Jin Cheng (S)

NON-AFFILIATED
Hung Ting Chang
Jaime B Newell

AATCC Deceased

Member	*Section*
EDGAR BRUNNER Porto, Portugal	—
B A ALFORD Cluett, Peabody & Co, Inc New York, NY	Met

Employment Register

This column is open for two insertions per year, per member, without charge. Blanks may be obtained from, and filed with, the secretary of the Association, Post Office Box 28, Lowell, Mass.

60-7

Education: High school and textile school—certificate in weaving, fabric & fiber analysis, designing and textile chemistry and dyeing.

Experience: 22 yrs; managerial positions in all phases of weaving production; plant manager of dyeing facilities; general manager.

Position desired: General manager or plant manager of pile fabric plant.

Location: West Coast preferred, East or South acceptable.

Age: 41; married; four dependents; references.

5-30, 6-13

60-8

Education: BSA, Univ of Cuba; graduate study in sales management; study visit in New York with dyestuff firm.

Experience: Dyestuff and chemical salesman, sales mgr, director of sales, vice president.

Position desired: Import-export mgr, export dept, American chemical or dyestuff mfr; sales mgr for agents in Latin American countries.

Location: Mexico, Puerto Rico, United States—South or East, Central or South America.

Age: 35; married; four dependents; references.

5-30, 6-13

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News of the Trade

Fine

Anderson

Comer

Davis

Refined Products Opens Offices in South

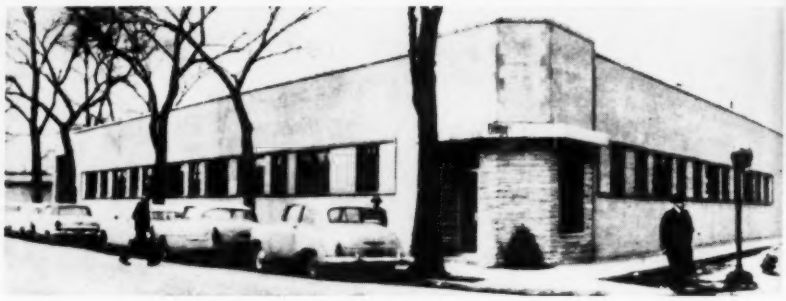
Refined Products Co, Lyndhurst, NJ, has announced the establishment of sales offices in Charlotte, NC, and Columbus, Ga.

In addition to complete sales facilities, a fully equipped application and research laboratory and warehouse have been completed at the Charlotte location for the purpose of serving customers in the southern area. The sales offices and laboratory are located at 2511 Lucena St, Charlotte.

Supervision of the laboratory will be the responsibility of George H Fine, who was formerly associated with United Merchants and Manufacturers.

Frank J Anderson Jr and Walter C Comer Jr have been appointed sales representatives in the Charlotte office. Mr Anderson was formerly associated with Warwick Chemical Co and Moretex Chemical Co. Mr Comer was formerly associated with American Cyanamid Co. Both men will represent Refined Products in the Carolinas, as well as parts of Tennessee and Virginia.

Thomas A Davis has represented Refined for many years, and will continue to handle sales in the Columbus, Ga area. The sales office in Columbus is located at 307 First National Bank Building.



View of Geigy Dyestuffs' new facility in Chicago

Geigy Dyestuffs Opens New Facility in Chicago

Geigy Dyestuffs, Division of Geigy Chemical Corp, Ardsley, NY, has moved its Chicago branch office to a new building at 5677 North Northwest Highway.

Geigy Dyestuffs has had a branch office for 14 years in quarters west of Chicago's Loop, which facilities have been outgrown by the expansion of the company's business.

The new branch office is a yellow brick, one-story, fully air-conditioned corner building comprising some 14,000 square feet of office, laboratory and warehouse space. The Laboratory is equipped to service the textile and leather industries in the Midwest and has ample expansion area to provide service facilities for the paper industry, to which Geigy Dyestuffs is also an important supplier.

Warren B Broadbent is Geigy Dyestuffs' branch manager in Chicago.

•

Koppers to Expand Chemical Plant

Koppers Company, Inc has announced plans to expand its Oil City, Pa, plant in order to produce a broader line of alkylated phenol. The new plant is expected to be on stream by July 1.

Among the first of the new products of this plant will be: para-tertiary butyl phenol; para-tertiary amyl phenol; di-tertiary amyl phenol; and both 2,4 and 2,6 di-tertiary butyl phenol.

According to Martin Fritch, manager chemical sales, the butyl and amino-phenols are primarily used in the production of oil-soluble resins, detergents and as oil and rubber additives.

CCL Buys Indianapolis Chemical

Charlotte Chemical Laboratories, Inc, Charlotte, NC, has purchased Indianapolis Chemical Co, Indianapolis, Ind. Products used in the hosiery and knitting industry will now be manufactured and sold by Charlotte Chemical Laboratories, Inc. At present, all prices will remain the same and the products will now be made and shipped from CCL's Charlotte office.

•

Nopco and Metasap Announce Vacation Schedules

Nopco Chemical Co and its Metasap Division have announced plans for their annual two-week vacation shutdown.

Nopco's plants in Harrison, NJ will be closed down August 6 through August 21; its Cedartown, Ga, plant will shut down from July 2 through July 17 and its Richmond, Calif, plant will close July 30 and open again August 15.

Nopco and Metasap urge their customers to place orders well in advance of the vacation periods to avoid inventory shortages.

•

GPC Suggests Equipment Coating During Textile Vacation Period

General Plastics Corp, 165 Third Ave, Paterson, NJ, which specializes in coating or recoating production equipment with Teflon, is again making arrangements to concentrate on this work during the first two weeks in July. The work will be scheduled so equipment can be returned to the mill and installed before production is resumed.

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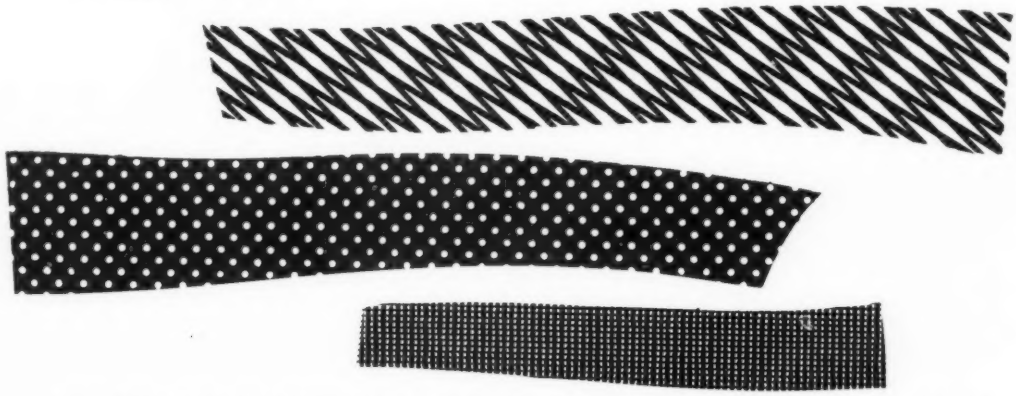

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Carus Chemical Opens End-Use Lab

Carus Chemical Co, Inc, La Salle, Ill, producer of potassium permanganate, has announced the opening of its new End-Use Research Laboratory to develop and evaluate processes using the company's products in the textile industry.

Potassium permanganate is being evaluated as a bleaching agent for both natural and synthetic fibers. Currently, potassium permanganate is being used in the textile field for removing stains, for stripping and for shrinkproofing and feltproofing of wool.

Technical personnel of the End-Use Research Department are available for consultation and field assignments.

A new 36-page technical brochure, "Bulletin No. 1, Properties and Uses of Potassium Permanganate", may be obtained by request on company letterhead to the End-User Research Department, Carus Chemical Co, Inc, Box 364, La Salle, Ill.

●

GE to Boost Silicone Production

An expansion program aimed at boosting production capacity to 1963 demand levels with emphasis on the production of newly developed products to meet industry's growing silicone needs is underway in the Silicone Products Department of the General Electric Company.

According to Jerome T Coe, department general manager, the program will be spread out over the next 22 months and will involve an outlay of several million dollars in new buildings, equipment and processes.

The initial phase of the program is construction of a manufacturing facility for silicone dispersions, emulsions fluids, and specialty products which will add 15,000 square feet to existing facilities. This is the first major construction since completion of a multi-million project two years ago, which involved the addition of approximately 45,000 square feet of research and development facilities.

●

"A Letter to Moscow"

A 28-minute color film portraying the strength of the American economic system of free enterprise is being distributed nationally by the Armstrong Cork Company.

The motion picture—"A Letter to Moscow"—is sponsored by the Company as part of its centennial observance.

"A Letter to Moscow" answers challenges voiced by Soviet Premier Nikita Krushchev during his visit to the United States in 1959, and illustrates how the nation's competitive enterprise system contributes to the high standard of living realized by the American people.

The film traces the growth of a typical American company and shows how it was able to develop and prosper in our free society.

The 16mm motion picture is available upon request to the Armstrong Cork Company in Lancaster, Pa, or any of its district offices.

●

Ciago to Expand Facilities

A substantial expansion of the synthetic-rubber-producing facilities of N V Chemische Industrie Aku-Goodrich (Ciago) at Arnhem, Holland, is now under way. Ciago is a jointly owned company formed in 1958 by B F Goodrich Chemical Company of Cleveland and Algemene Kunstzijde Unie N V of Arnhem.

Production began in Ciago's original facilities in the summer of 1959. The plant produces butadiene-styrene-type latex, used in making foam rubber. Hycar nitrile latex goes into a variety of products, including leather finishes, textile sizing and finishing, paper saturation, and as a binder for nonwoven fabrics.

The decision to expand Ciago's production facilities was based on the firm's constantly expanding sales volume in continental Europe. The new facilities are expected to be completed by early 1961.

BFG Chemical has similar synthetic rubber plants under joint ownership in Japan and England.

●

Textile Opportunities Stressed At Phi Psi Employment Seminar

The textile industry welcomes competent men and takes good care of them over the long term, it was emphasized in and during the Employment Seminar at the 57th Annual Convention of Phi Psi Fraternity, held recently at the Hotel Roosevelt, New York.

The panel discussion, led by Douglas F Grady of Pepperell Mills, covered every aspect of the textile employment picture, from recruitment through training and promotion.

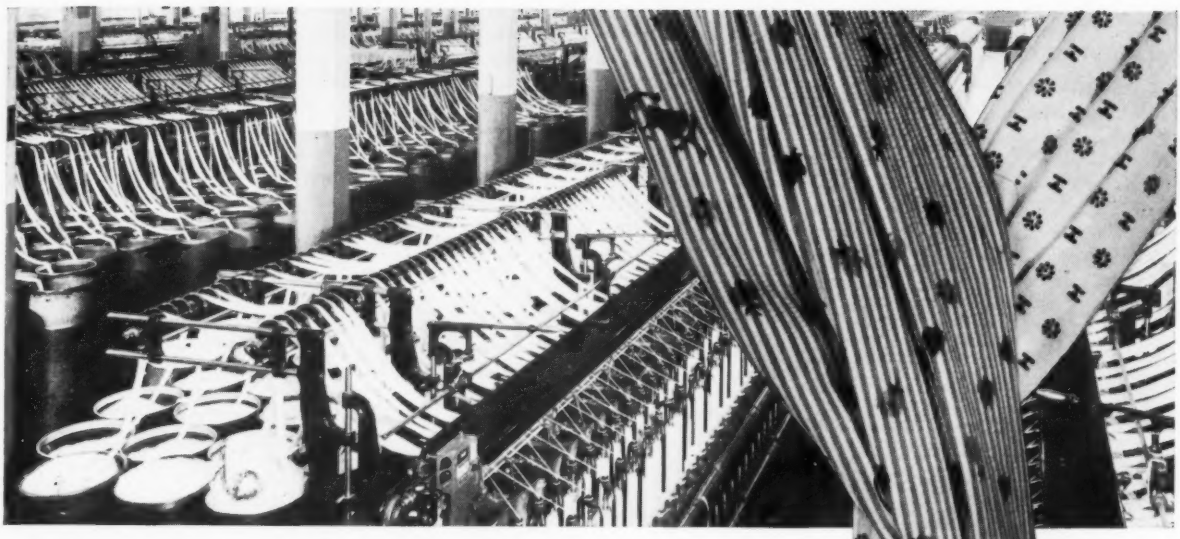
Two phases of executive development, in-company training and self-development, were stressed by Allen Morris, director of sales training and executive development for Burlington Industries, Inc. Said Mr Morris. "We in Burlington are firm believers in on-the-job training after a brief formal orientation period; but any training program provides only the framework. The executive trainee must decide for himself how high above the plateau of security he wants to go. Then, with these self-imposed and self-inspired goals he can direct himself to their achievement."

Pointing out that only five out every 100 men achieve financial success from age 25 to age 65, Mr Morris said that, of the 14-million people in the US now over 65, some 13 million of them are broke. "We take our abundance and opportunity for granted, and too many young people settle for conformity as a substitute for courage. The men who succeed are those who develop themselves rather than depend on their employers to do all the work for them."

Lewis Benton, director of personnel at M Lowenstein & Sons, whose topic was "Going Outside vs Promoting From Within," decried the policy of some companies to disregard talent within their own organizations. "We don't recruit nor do we advertise, but we get more trainee applications than we can accept. This is because our firm policy of promoting from within has become so well known in the textile industry.

Mr Benton said that going outside indicates a lack of management planning and is most discouraging to insiders who must have hope for advancement in order to function effectively in their present positions. "The best example of our promotion policy is our president, Everett Drake, who started at $13 a week and learned the business from bottom up—largely on his own time and on his own initiative outside of working hours."

On the question of whether textile-school graduates or those with non-technical degrees are better fitted for textile jobs, Marshall Palmer, director of administration at J P Stevens & Co, came out in favor of the textile graduates. Limiting his remarks to "sales-engineering" positions in New York, Mr Palmer said, "Our job in New York is to service our customers, and we feel the men who can do this best are those who know most about our products and how they are made. We employ general college graduates, and in some areas, such as domestic products, they are just what the doctor ordered. But in other departments, such as industrial and specialized textiles, we find that the textile-college graduates get off to a faster start."



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"Wash-Wear" Cottons Featured at Experiment Station Meeting

More than 10 million bales of cotton going into domestic consumption by 1965 was seen as a possibility by officials of the National Cotton Council of America, speaking at a conference of Southern Experiment Station representatives held at the U S Department of Agriculture's Southern Regional Research Laboratory in New Orleans, La.

Such an increase would require an increase of just 4% of the total amount of all types of fibers consumed by the domestic market, but it will be dependent on improved quality and greater usefulness, Frank McCord, of the National Cotton Council, told his audience. Such advances can be brought about through research, not only on "wash-wear", but on ways of improving other properties of cotton, he said. Consumption of cotton by the expanding apparel market has risen from 56% in 1947 to 61% of the total in 1959. He gave credit to "wash-wear" and easy-care fabrics with cotton's gains in many areas of apparel uses, and with prevention of losses in other areas.

George S Buck, also of the National Cotton Council, said that within the past two decades research has reduced the cost of producing cotton by 9¢ per pound.

Subject of the conference was "wash-wear" cottons. The present status and future prospects of "wash-wear" were thoroughly explored during the three-day meeting by representatives of the textile industry, chemical companies which manufacture "wash-wear" finishes, national retail merchandisers, and state and federal research agencies in attendance.

Members of the scientific staff of the Southern Utilization Research and Development Division, USDA's cotton utilization research center, reported in a dozen technical papers on advances in "wash-wear" research.

Use of formaldehyde as a treatment to impart "wash-wear" properties was described in one of the papers from the Southern Division. It was reported that the formaldehyde treatment gives satisfactory wrinkle resistance, while offering the advantages of low cost and resistance to discoloration by chlorine bleaches during laundering.

Another Southern Division development attracting considerable interest was the prototype of an automatic wrinkle-recovery tester demonstrated during a talk on testing of "wash-wear" fabrics. The instrument is aumatic, which enables an operator to test a greater number of samples in a given time than with other methods, and also reduces opportunity for error.

Throughout the discussions, speakers emphasized that, although "wash-wear" cottons are relatively new on the market, a wide range of excellent products are available. Statistics showing a growing demand for "wash-wear" cotton garments were taken as evidence that these products are well liked. Increases in sales have been most pronounced in outer apparel, such as skirts, blouses, and dresses, in which appearance is of primary importance.

Clara Tucker, head of the Department of Home Economics, Louisiana State University, Baton Rouge, said that "wash-wear" and easy-care cotton garments not only reduce the labor of upkeep, but go through a day's wear with a fresh, unmussed appearance, which adds to their appeal.

Among the greatest needs at present are more accurate labelling, closer control of quality, and some solution to the pricing problem, so that the fractional increases in cost due to the use of better finishes and better processing methods can be kept to a more realistic level as applied to the completed garments.

Harry C Donaldson Jr, Cluett Peabody & Co, pointed out that present-day commercial "wash-wear" finishes are good, as is proved by consumer acceptance, and that advantages outweigh drawbacks. As a note of encouragement, he reminded the audience that advances in "wash-wear" have been more rapid than in many other developments, such as the home washing machine, within the first five- or ten-year period of commercial production.

The confusion in labelling which confronts consumers was cited by a number of the speakers. It was suggested that closer quality control by manufacturers of "wash-wear" finishes, and some kind of agreement on a more consistent system of labelling would be extremely helpful to everyone concerned, including consumers.

Cost was mentioned frequently by industry representatives an an important influence in determining the quality of the "wash-wear" finish used. Under the present pricing system, it was pointed out, use of the better-quality resins might cost only pennies per garment, but that by the time this garment reached the sales counter of the retail store, this small initial cost might add 50¢ or a dollar to the selling price of the garment. This price increase would then have a substantial effect on sales.

There were indications that through several years of experience, the "wash-wear" situation is beginning to clarify itself. In his review of the statistical situation, Mr McCord said that, although it had been expected that acceptance of "wash-wear" sheets would be widespread, this demand has not materialized, due largely, he said, to the use of fitted sheets. Eleanor L Fisher, of Sears, Roebuck, said that they have discontined "wash-wear" treatment of work clothes to a great extent because it had less sales appeal than some other properties, such as long wear.

Latest statistics on consumption of cotton for specific end-uses in relation to other fibers, as presented by Mr McCord, showed some definite trends in the production and utilization of resin-finished, easy-care cottons as well as cottons in general. Production of resin-finished cotton fabrics increased from 600 million linear yards in 1955 to an estimated 1,900 million in 1959, representing 63% of the total of easy-care fabrics for that year. Utilization of resin-treated cotton fabric in sports shirts showed an increase in percentage use. Dress and sport trousers showed an increase, and work trousers a decline. Percentages of the total used for women's and misses dresses, blouses, skirts, and most other items increased, as it did in most lines of children's wear. Among household uses, retail piece goods and several other lines showed sizeable increases.

Mr McCord said that if current trends in the total consumption of fibers continue, the domestic market including man-made fibers, jute, etc, which was the equivalent of 18.7 million bales of cotton in 1959, will exceed the equivalent of 20 million bales in 1965, and pass 21.5 million bales by 1970.

"Obviously, cotton can never displace all competing materials. On the other hand, significant improvements in 'wash-wear' and other qualities should enable cotton to achieve further competitive gains . . . if cotton accounts for 46% of fiber consumption in 1965, as it did in 1959, consumption in the 400 end-uses on which we maintain quantity data would total 9¼ million bales compared with 8.6 million bales in 1959. If cotton's percentage declines to 40% of the total fiber consumption, demand in 1965 will be only 8.5 million bales, or slightly less than in 1959.

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If cotton's percentage can be raised to 50%, consumption will exceed 10 million bales by 1965."

C L Hoffpauir, assistant director of the Southern Division, speaking on further progress in "wash-wear", outlined some of the goals of research to improve the competitive position of cotton in both "wash-wear" and other fields. Factors which play a large part in determining consumer satisfaction, he said, are aesthetic consideration, ease of care, comfort, durability and economy. Both he and other speakers referred to the desirability of improved luster, color, and other elements of appearance, permanent crispness, drapability, resistance to abrasion, fire, heat, insects, soiling, and a wide range of other properties, all of which are suitable areas for research.

•

GAF to Increase Production Capacity at Calvert City

The first step in a five-year expansion program to increase production capacity at its Calvert City, Ky, plant in its Dyestuff & Chemical Division to meet anticipated sales in acetylene chemical products, surfactants and intermediates was announced May 6 by General Aniline & Film Corporation.

The company will expand its facilities at the Kentucky plant in the manufacture of such acetylene chemicals as pyrrolidone and vinylpyrrolidone and also for surfactants and intermediates now being produced there which formerly were made only at the Linden, NJ, operations.

The company said that the expansion program is based upon anticipated expanding market requirements during 1960 and through 1965 and that significant progress was made in 1959 and the first quarter of this year in its acetylene chemical sales.

The continued increase is expected to develop as a result of exploiting known applications and existing product uses in expanding known markets. The acetylene products manufactured at Calvert City are used as components or manufacturing supplies in the production of a broad range of high-volume products which are produced by nationally known firms.

General Aniline & Film, the only producer of the PVP family of high-pressure acetylene chemicals in the United States, expects that as its application research and market development continue to expand, many new uses will be developed for these products.

Acting board of directors for the recently organized Tricot Institute of America Inc is shown. Seated, l to r: N O Robbins, Webco Mills, vice president; Charles E Lovett, Deering, Millken & Co, president; Roy Reubel, J P Stevens & Co, Inc, vice president. Standing, l to r: Victor Goldberg, Glen Raven Mills, treasurer; George Tunick, Bangor Mills, vice president; and Lee Parsons, American Cotton Manufacturers Institute, secretary.

Tricot Institute to Form Technical Group

The Tricot Institute of America, Inc, formed last March "to help the tricot industry secure an ever-increasing share of the market by a continuous and saturating promotional effort", numbers among its plans the formation of a technical group, one of the aims of which will be the formation of a standards committee to bring to the tricot market for the first time recommended fabric standards for slips, panties and other items. Purpose of such standards would be to upgrade tricot fabrics in general.

It is expected that most of the 120 tricot mills in the U S will become members of the new Association. In addition to mill operators, who are classified as "active members", TIA has set up an associate membership class for related companies, such as yarn producers, machinery manufacturers, dyeing and finishing plants, chemical companies, and factors.

Edward M Meyers Associates, Inc, advertising and public relations firm, is directing the Institute's promotional program.

•

PTI Awards Three Honorary Doctorates at 75th Anniversary Exercises

"The primary commitment of our schools is neither to employers of our graduates nor to specific groups of scholarly concepts, but to the students we teach," stated James Creese, president, Drexel Institute of Technology, at the recent Convocation-Dedication ceremonies on the Germantown campus of the Philadelphia Textile Institute. The ceremonies climaxed the 75th Anniversary of the college and of textile education in the United States.

Dr Creese, in outlining the emergence of PTI and other technical schools on the American educational scene, added, "A new power began to move in the world of learning, disturbing its old tranquility. Room had to be made for science and technology. The power is still new, revolutionary and disturbing. Its impact altered all our ways of working, all our habits of thought, and all our relations with one another at home and with nations abroad."

Honorary Doctor of Laws degree were awarded at the ceremonies to Dr Creese, presented by William F MacDonald, first vice-president, board of trustees; to Senator Hugh Scott, presented by Frederic H Barth, Postmaster of Philadelphia; and to Albert M Greenfield, chairman of the board, Bankers Securities Corp, presented by Richard S Cox, dean emeritus of PTI.

Two buildings dedicated at the ceremonies were Althouse Hall, a student building, named for C Scott Althouse, former president and founder of the Althouse Chemical Co, Reading, Pa, and Scholler Residence Hall, named for the late Frederick C Scholler, former president of Scholler Brothers, Inc, Philadelphia, and one-time president of the Philadelphia Textile Institute Foundation.

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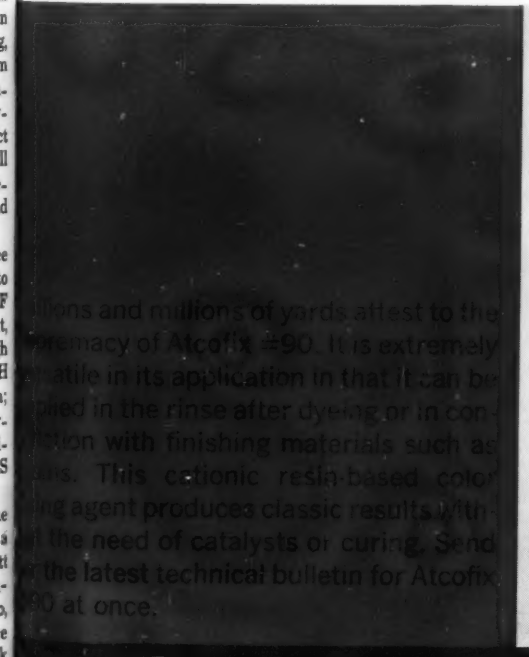

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Cellulose chemistry is discussed by Lea Valtasaari, left, of the Cellulose Institute, Helsinki, Finland, with Mary L Nelson, at the Southern Utilization Research and Development Division of the U S Department of Agriculture in New Orleans, La. Dr Nelson is one of the scientists in the Plant Fibers Pioneering Laboratory. Among other subjects they discussed advantages and disadvantages of the sodium ferric tartrate and copper solvents for cellulose, polymerization, and X-ray techniques. Dr Valtasaari has been at the Brooklyn Polytechnic Institute as a Fulbright Scholar for several months. In Finland she works under Olli Ant-Wuorinen, head of the Chemistry Department, and is engaged in studies on the chemistry of cellulose.

Cooper Union Exhibit Highlights Color

The Cooper Union for the Advancement of Science and Art is celebrating its Centennial Year by presenting in its Museum an exhibition called "The Logic and Magic of Color", an exposition of the scientific, symbolic and aesthetic aspects of color.

Continuing through August, the show seeks to bring together for the first time all the ways in which colors and colorants evolve and affect people in their living, their enjoyment and their work.

The visitor is shown a series of demonstrations of the physics of light, beginning with the prismatic refraction of light into its spectral colors, then an exploration of optical phenomena. An exposition of color chemistry traces the development of pigments, dyes and glazes from earliest times to the complex synthetic colorants of today, and is illustrated with samples of textiles, glass, ceramics, paper, painted objects, and plastics.

Color symbolism, color preference in fashion and in home fashion and color as a motivating factor in commerce are illustrated. A series of panels show results of some of the newest research in psychology based on associative reactions to color.

An imposing demonstration is made of color measurement systems. Examples of the Munsell Color Tree, the Ostwald Color Solid and the CID Color Solid are shown along with paintings and weaving bases on one or another of the color systems. A working spectrophotometer is available to show how precisely a color can be measured today.

The simple exuberance of the sensation of color is provided by selected objects from the Museum's collections and from outside sources.

The exhibition has been assembled by the Museum with the help of innumerable contributors of material and information; among them: Allied Chemical Corp; The American Museum of Natural History; Brookhaven National Laboratory; The Brooklyn Museum; Ciba Co, Inc; Color Association of America; Container Corp of America; Corning Glass Center; Dexter Chemical Corp; General Electric Co; Interchemical Corp; Metropolitan Museum of Art; Munsell Color Co; National Bureau of Standards; Sun Chemical Corp; and Union Carbide Corp.

•

Allied Chemical Nylon Expansion

Allied Chemical has confirmed that Chesterfield, Va will definitely be the site for a portion of their announced nylon expansion. Facilities for making Caprolan heavy denier nylon for industrial uses are located there. A program to triple existing capacity of nylon yarn for tire cord is underway.

James G Fox Jr, president of Allied's National Aniline Division, stated that engineering studies for the new plants are approaching completion and that initial fine denier operations are expected by the second quarter of 1961.

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LTI Undergraduate Program in Chemistry Approved by ACS

The new undergraduate curriculum in chemistry at Lowell Technological Institute has been approved by the American Chemical Society, said Martin J Lydon, president of the Institute, in a recent announcement which indicated the gratification of the chemistry faculty at ACS acceptance of the program on the Institute's first application for approval.

Various curricula of the Institute are credited also by the Engineering Council for Professional Development and the Senior College Division of the New England Association of Colleges and Secondary Schools, in which association LTI holds full membership.

In commenting on the ACS approval, George R Griffin, chairman of the LTI Division of Chemistry and Applied Chemistry, remarked, "This indicates further recognition by professional accrediting organizations of the continuing growth and development of Lowell Technological Institute's program in science and engineering."

OBITUARY

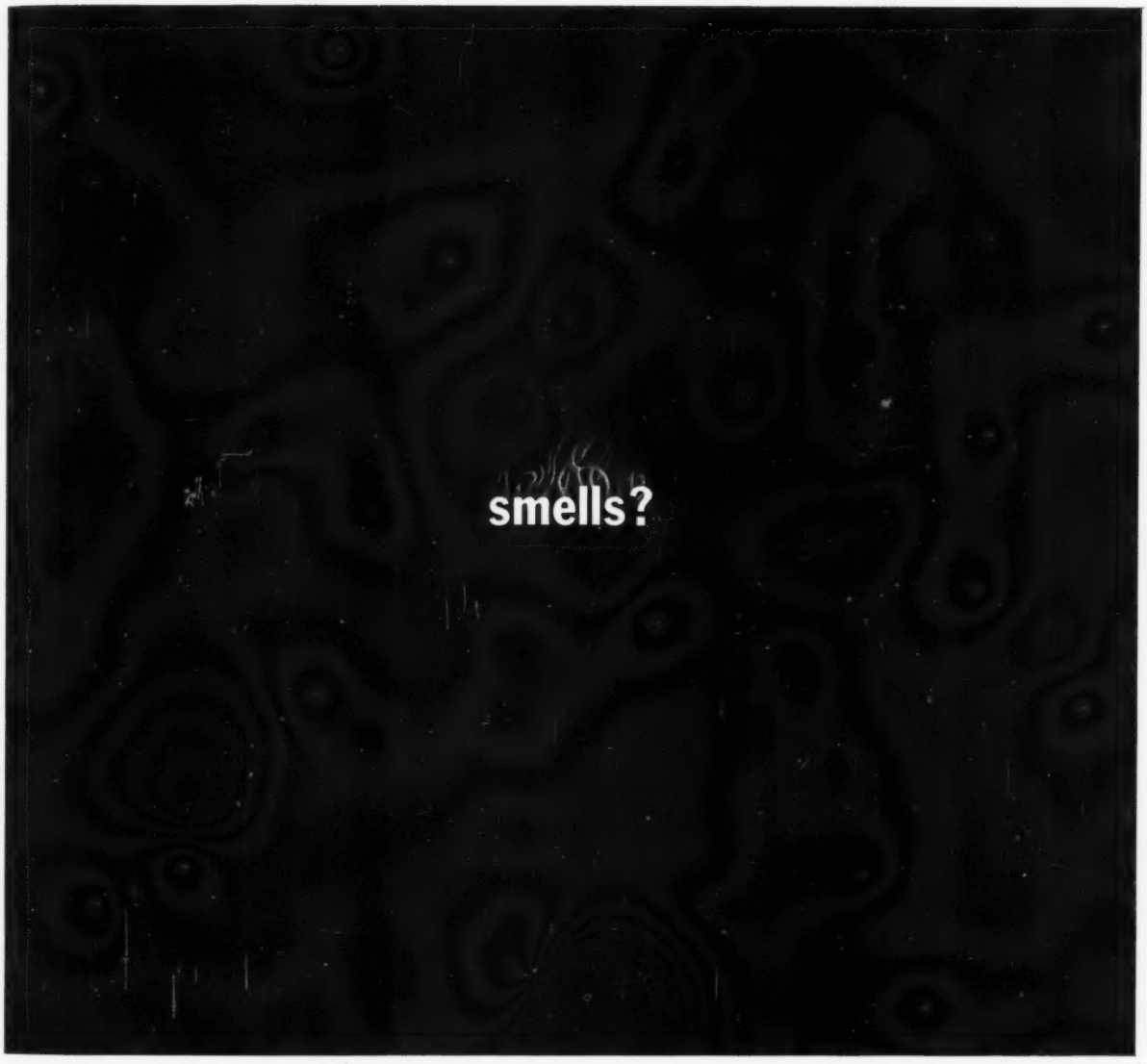
ROSS C RODGERS, president of Scholler Brothers, Ltd, St Catherines, Ontario, a subsidiary of Scholler Brothers, Inc, died suddenly at his home in St Catherines on May 24. He was 58 years old and is survived by a son, William, and daughter, Mrs Jean Gilmore, both of St Catherines.

Mr Rodgers was born in Philadelphia. He joined Scholler Brothers, Inc, 34 years ago and soon after was transferred to the newly established Canadian company of which he became president several years ago.

•

DAVID E PHILPOT, a teacher for 47 years in the A French Textile School of the Georgia Institute of Technology, died on Wednesday, April 6.

Mr Philpot was 76 years of age at the time of his death, which occurred in a private hospital in Atlanta. He retired from Georgia Tech in 1954.



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• NAMES IN THE NEWS •

Speel

Henry C Speel has joined Universal Oil Products Co, Des Plaines, Ill, where he will have responsibility for market research activities of the chemical products development department.

Mr Speel formerly was a partner in the chemical consulting firm of Schwarz, Speel and Associates. Before entering the consulting field, he was director of development for Wyandotte Chemicals Corp.

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Leslie L Walmsley and *Irving H Welch* have been promoted in American Viscose Corp's Technical Service Department.

Mr Walmsley, previously head of the Dyeing and Finishing Division, has been promoted to the newly created position of converting relations technical advisor. In this position he will assist *Arthur R Wachter*, head of converting relations, as a technical advisor and industry consultant particularly on the several new rayon fibers which American Viscose is introducing.

Mr Welch succeeds Mr Walmsley as head of the Dyeing and Finishing Division.

•

Robert R Alexander has joined the Dewey and Almy Chemical Div, W R Grace & Co, Cambridge, Mass, as research chemist in the Organic Chemicals Division.

He has been with the Callaway Mills Co for six years.

•

Imperial Color Chemical & Paper, a department of Hercules Powder Co, has appointed *William N Tune Jr* as director of technical sales and *Paul H Eliot* as district manager in Atlanta.

Mr Tune has been district manager for Imperial in Atlanta since 1951. He will headquarter in Glens Falls, NY, after June 15.

Mr Eliot joins Imperial from Titanium Pigments in Cleveland where he was employed in a sales capacity since 1951.

George S Wham joined Phillips-Van Heusen Corp on June 1st as director of research, testing, and product development. He will make his headquarters at the company's New York executive offices.

Dr Wham was formerly director of textiles and textile editor of *Good Housekeeping*. He was also technical director of the Good Housekeeping Institute.

At Phillips-Van Heusen, Dr Wham will be associated with *Thomas D Ainslee*, a director of the company and executive director of research testing and product development.

Dr Wham will continue to serve as chairman of AATCC's Technical Committee on Research.

•

Cruickshank

Stott

The appointment of *William E Cruickshank* to position of plant manager and *Ralph Stott* to plant superintendent has been announced by Bradford Dyeing Association, USA, Westerly, RI.

Cruickshank has been with Bradford for thirty-five years and for the past three years has been the plant superintendent.

Stott has been the superintendent of bleaching division and has been with Bradford for eleven years.

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Carl F Prutton, executive vice president of Food Machinery and Chemical Corp, New York, received the honorary degree of doctor of engineering from Clarkson College of Technology, Potsdam, NY, during its 67th commencement exercises on Sunday, June 5.

•

Dan Kaufman has been promoted to the position of supervisor of inorganic research in the Research Division of Wyandotte Chemicals Corp. Mr Kaufman has been assisting in the coordination and planning of several research projects in the inorganic area and will assume additional responsibilities in this department.

Smith

Ernest D Smith has been elected vice president and general manager of the Southern Division of Organic Chemical Corp, East Providence, RI. Organic recently opened its new sales office warehouse in Concord, NC, having moved to larger quarters from Charlotte.

•

Nelson S Knaggs, vice president in charge of sales, The Hilton-Davis Chemical Co, Division of Sterling Drug Inc, Cincinnati, was a guest on April 28 at two high-level social functions held in honor of the King and Queen of Nepal in Washington, DC.

Mr Knaggs, a director of the Explorers' Club, visited Nepal in 1956. He was granted an audience then by *King Mahendra*, to whom he presented a golden key to the city of Cincinnati and a diamond-studded watch as a gift from the citizens of the city.

King Mahendra and Queen Ratna started a month-long visit on April 27 to the United States, Canada and Mexico. On the following day, they were given a reception by the Nepalese Ambassador in the nation's capital, to which Mr Knaggs was invited. He was a guest the same night at a formal dinner given by Acting Secretary of State *Loy Henderson* for the visiting monarch. Mr Knaggs presented the king with a portfolio of photographs which Mr Knaggs took during his 1956 trip to Nepal.

Mr Knaggs, who is also vice president of the Cincinnati Museum of Natural History, made a documentary film of the Himalayan kingdom called "Nepal—Kingdom in the Sky," which has been widely viewed.

•

Appointment of *Robert E Sanner* as training director of the A E Staley Manufacturing Co has been announced.

Mr Sanner had been a training and communications specialist with General Electric in Utica, NY, for the 3½ years.

Swanson

Harold A Swanson has been named vice president in charge of the Technical Products Division of E F Drew & Co, Inc.

Mr Swanson will direct all marketing, sales and research for the Division, which is the source of Drew-originated products and processes in the fields of fatty acids and derivatives, textile chemicals, chemical compounds and a variety of other technical products. The new vice president will also head the Quality-Control Committee for the Technical Products Division.

Before joining Drew's executive staff, Mr Swanson was vice president and director of Nopco Chemical Co, Newark, NJ, with whom he was associated for 23 years.

Mr Swanson will direct his Division from the New York offices of Drew.

•

Alfred H Drewes and *Sidney F Thune* have been added to the board of directors of National Starch and Chemical Corp.

Mr Drewes is a vice president, director and member of the Executive Committee of National Lead Co. He is also director of a number of other companies.

Mr Thune is vice president in charge of adhesive and resin sales of National, and has been associated with the company since 1932.

William H Stone has been appointed Southeastern Division manager for the paper, textile and food industries with headquarters in Atlanta. He joined National in starch sales in 1946, and in 1956, he became Midwest starch sales manager at Chicago.

Stone

Arthur G Pope, for the past year and a half sales supervisor for the Western district of Du Pont's Dyes and Chemicals Division of the Organic Chemicals Department, has been appointed manager of that district for the division. At the same time, the division's Western district headquarters has been moved from Los Angeles to Palo Alto, Calif.

•

Ray C Houtz has been appointed to the new post of technical director for The Toni Co, a division of The Gillette Co.

Dr Houtz, who previously served as Toni's laboratory director, joined the Company in 1954 as director of basic research and service operations.

At the same time. it was announced that *Herman Bogaty* will succeed Dr Houtz as laboratory director. Formerly, he served as associate research director in the operations division.

•

Eight staff members who have been with Fabric Research Laboratories, Inc, Dedham, Mass, for ten years or more were honored on May 9 at a dinner party held at Valle's Steak House, Chestnut Hill, Mass. All 45 of FRL's current staff members and their guests were present.

The eight are: *Milton M Platt, Henry M Morgan, Chauncey C Chu, Jules J Amirault, Robert J Coskren, Marie P Daley, Jeanette H Rea* and *Mildred N Cheskis.*

Two staff members who are no longer with FRL but were on the staff for ten years were also honored, one posthumously. *George Thomson* joined FRL in 1948 and was an assistant director until his death last year. *Marijane Hamilton* was one of the original FRL employees when the company started in 1942 and is currently working on a doctorate in sociology at the Winfield State Hospital, Winfield, Kas.

•

Rodney Hunt Machine Co, Orange, Mass, has announced the appointment of *Michael H Hartney* as sales engineer for its Industrial Roll Division. He will use the Orange office as his headquarters.

•

The appointment of *Salvatore J Rand* to the Corporate Research and Development Dept of Colgate-Palmolive Co has been announced.

Dr Rand, whose major field of interest is physical chemistry, will work in the Basic Chemical Research Section at the Colgate-Palmolive laboratories in Jersey City.

Kraner

Karl T Kraner has been appointed marketing manager for Kessler Chemical Co, Inc, Philadelphia, Pa. In his new position, Mr Kraner is in charge of all sales and sales development activities for Kessler. He previously served for twelve years in the sales and marketing departments of Atlas Powder Co.

•

L J Sheps, president, Trilon Chemicals Ltd, Lachine, Que, was named president of the Textile Technical Federation of Canada for his second year at the 21st annual meeting of the group.

Dr Sheps was recently honored with bronze medal of the Quebec Section, CATCC.

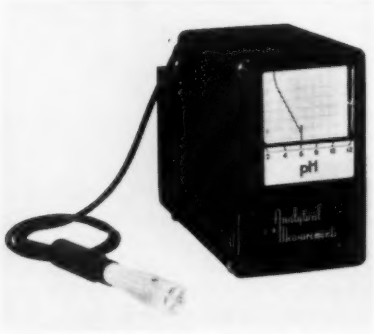
Officers elected were: Dr Sheps, president; *S J Hungerford*, Du Pont of Canada Ltd, past-president; *J M Nodtvedt*, Chemcell Fibres Ltd, vice president and director; *A H Miller*, Scholler Bros Ltd, vice president and director; *G Marshall*, Courtaulds (Canada) Ltd, honorary secretary-treasurer and director; *J M Merriman, Canadian Textile Journal*, secretary. Other directors are: *S H Chambers*, The Montreal Cottons Ltd; *C V Grantham*, W J Westaway Co Ltd; *G C Tattersfield*, Ayers Ltd; and *C H Bayley*, National Research Council.

•

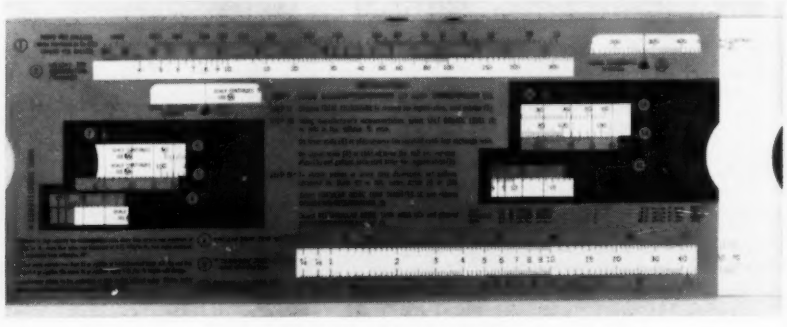
Seydel-Woolley & Co has appointed *Charles W Braswell* technical sales representative of its Finishing Chemical Div for the Alabama-Georgia-Tennessee territory.

Mr Braswell was previously connected with Dyeing and Finishing Div, Standard Knitting Mills, Knoxville, Tenn.

Braswell



Analytical recording pH meter with pH probe unit



Morton ion-exchange calculator

Combined pH Meter and Strip Chart Recorder

Analytical Measurements, Inc has introduced a combined pH meter and strip chart recorder at a price which, it is claimed, is lower than most conventional pH meters alone.

This instrument utilizes an electronically modulated amplifier that compensates for line voltage fluctuations and uses standard radio tubes. A strip chart recorder forms the front panel of the instrument and contains a 63-ft roll of chart paper that will last for 31 days at one inch per hour. Other chart speeds are available up to 16 inches per hour by a gear change. A pressure-sensitive coating is used on the chart paper. Connections for insertion of a platinum resistance thermometer reportedly provide automatic temperature compensation. A switch on the front panel permits disconnection of the chart drive so that the instrument becomes an indicating pH meter. The Analytical Revolutionary pH Probe Unit reportedly provides a unitary glass electrode system completely protected by polyethylene which makes possible pH monitoring that heretofore has been impractical because of complicated installation or excessive instrument costs.

The Analytical Recording pH Meter with pH Probe Unit sells for $195.00 fob Chatham, NJ.

For further information, send for illustrated brochure No. 3-R to Analytical Measurements, Inc, 585 Main St, Chatham, NJ.

•

Morton Ion-exchange Calculator

Morton Salt Co, 110 North Wacker Dr, Chicago 6, Ill, is offering a new calculator for determining the requirements of a water-softening installation. It is stated that one can quickly figure the conversion of ppm water hardness to grains per gallon hardness, the amount of exchange resin needed, the brine and salt adjustments. The calculator is said to be useful in selecting tank sizes for liquid volume problems.

•

Ceron

A new family of water-soluble polymers, useful as thickeners, protective colloids, and suspending agents, is described in product data available from Hercules Powder Co, Wilmington 99, Del.

Called Ceron, the new chemical is available as a nonionic material, a product which is anionic in nature, and a product which is cationic. In addition, Ceron N, nonionic, is available in three different types.

Chemically, the new water-soluble polymers are polymeric carbohydrates etherified to give the water solubility, physical and mechanical properties, and other desired characteristics. Because of their chemical compositions, and the manufacturing processes used, they are said to offer certain advantages.

In solution properties, the Ceron polymers have certain characteristics similar to starches. However, they are reported to be soluble without cooking and do not retrograde. Solutions, even of the very low viscosity types, can be prepared without color degradation; and viscosities are stable with no increase on aging, it is claimed.

Ceron N types reportedly have wide utility as thickeners, sizings, and emulsion stabilizers. Ceron N-4S can be used as a water-soluble thermoplastic.

Ceron N-4E, a very low viscosity, low-molecular-weight type, is said to be outstanding for its color and color stability, high solids solution, stable viscosity, and film quality. All Ceron N grades reportedly can be readily insolubilized with suitable reagents, a property of particular interest in textile finishes and coatings.

Ceron AN is anionic, providing a net negative charge when in solution. This grade is said to have aroused special interest as a suspending agent and thickener in emulsion polymerization reactions. Ceron CN, on the other hand, contributes a net positive character to its solutions, since its substituent groups are polar in nature. It is utilized in certain emulsifications, and is reported useful in cotton textile processing since it has an affinity for the anionic cellulose fiber.

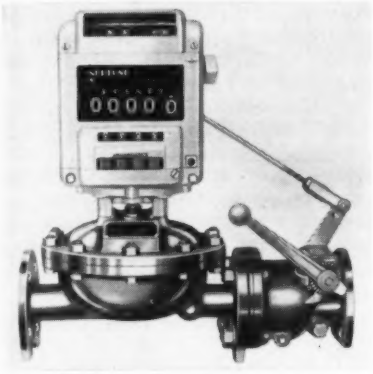
•

Sinagen Golden Yellow, Sinagen Yellow 2G pure

Rohner Ltd, Pratteln, Switzerland, reports that two of its yellows are attracting considerable attention.

Sinagen Golden Yellow is a homogeneous dyestuff of high color yield, reportedly giving golden-yellow shades of outstanding fastness to light, washing, and chlorine on all cellulosic fibers. This dyestuff is developed by neutral or acid aging, or in an acid bath.

With Sinagen Yellow 2G pure, it is claimed that greenish-yellow shades of good fastness to light and washing are obtained on all cellulose fibers. Outstanding features of the dyestuff are said to be good color yield, good stability in the printing paste and high coupling speed. Sinagen Yellow 2G can be printed along with vat dyes without the latter influencing the Sinagen prints, is is claimed. Development is carried out in neutral steam, by acid aging, or in an acid bath.



Neptune Auto-Stop meter

Neptune Auto-Stop Meter

A new 1½" stainless-steel Auto-Stop meter provides controlled measurement of predetermined quantities for batching and processing systems where corrosive liquids are used.

The new meter functions almost automatically. Buttons are pressed on the register face to set the quantity and open the valve. The liquid flows unattended until the preset quantity is reached; then the Auto-Stop valve cuts off flow automatically.

The new meter is based on the positive displacement principle, with only one moving element exposed to the liquid. This design reportedly achieves fine-instrument accuracy with a smooth, nonpulsating action and few working parts. Precision-machined clearance between chamber and disc are said to prevent costly wear or excessive slippage.

The meter has a capacity range from 20 gpm minimum to 100 gpm maximum.

Units can be furnished with auto-switch control feature, repeating auto-stop, ticket printer, or any combination of these features in addition to the auto-stop.

In units with auto-switch control feature, an electric switch is actuated by the auto-stop when the predetermined quantity of liquid has been delivered. This switch can be used to start or stop pumps, valves, agitators, signals and other equipment.

Meters can be calibrated for US or Imperial gallons, liters or pounds. Once set, the positive-locking calibration adjustment mechanism cannot slip or drift, it is claimed. If changes or corrections are required, they can be made by Neptune's patented gear shifter.

Further information is available from Neptune Meter Co, 47-25 34th Street, Long Island City 1, NY.

HYDROCHLORIC ACID POURED IN HAND—The protective power of an industrial barrier cream is shown in this photograph. These hands reportedly were coated with Kerodex type 71 barrier cream, a product of Ayerst Laboratories, as a protection against irritants. Then a bottle of pure hydrochloric acid was slowly poured into the palm, running down and around the fingers before splashing off. During part of this test, the hand was clenched and unclenched to prove the resilience of this so-called "invisible glove." After washing, inspection of the skin reportedly revealed no trace of burning or blistering. This cream is made in several types to provide workers with positive protection against hazards of skin-damaging chemicals and irritant agents.

●

Dacryl Green LFG

A new disperse dye developed especially for polyester fibers has been announced by Althouse Chemical Co, Reading, Pa. The dye, designated as Dacryl Green LFG, was developed by Althouse chemists to fill a necessity for a true green which previously was lacking in its disperse color lines.

In addition to applications for the polyester fibers, Dacryl Green LFG reportedly can also be applied to the usual acetate and polyamide fibers.

The new green is said to have excellent fastness to washing, drycleaning, sublimation and light when applied to polyester fiber and is recommended by Althouse for maximum fastness properties.

Dacryl Green LFG reportedly may be applied to polyester fiber at normal dyeing temperatures with conventional carriers or it may be applied at elevated temperatures without the use of any carrier. It is claimed that the dye has excellent stability at elevated temperatures, exhausts well in neutral bath, and has superior pile-on properties. It is recommended by Althouse for the dyeing of stock and yarn, as well as woven and knit fabrics.

Labline bench-type oven

Industrial Bench Oven

A temperature range to 500°F reportedly has been incorporated into an improved forced-air, bench-type oven by Labline, Inc, 3070-82 W Grand Ave, Chicago 22, Ill. The new oven is designed for industrial heating, drying, annealing and other plant and laboratory uses where controlled heating is needed.

The oven has a four-cubic-foot working chamber and is 31" wide. The low-wattage heating elements are Inconel enclosed; there are no exposed resistance wires to break or corrode, it is stated.

An exclusive feature is said to be the design of the diffuser baffles, which direct heated air from blower evenly across the shelves. Temperature uniformity reportedly is maintained within ±2°F accuracy. Hydraulic thermostat is said to be UL approved.

The sliding stainless-steel shelves are perforated to permit even air flow and are adjustable every three inches in height. Unit comes in enamel exterior or stainless steel.

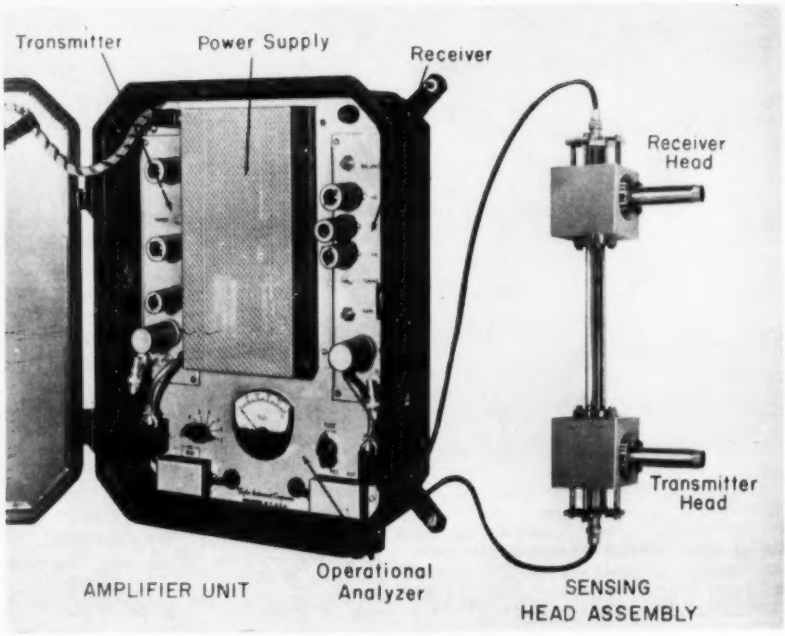
Overall size: 31" wide × 44" high × 23" deep. Lists at $750.00.

●

Dake Resin Mixer

Designed for faster, more efficient resin blending, the new self-supporting drum-type Dake resin mixer has a disc-type blade which reportedly shears in and disperses solid materials rapidly with a minimum of air entrapment. According to the Dake Corp, Grand Haven, Mich, manufacturer of the unit, a bottom-to-top blending action effects a perfect, uniform mix, and the low-heat build up lessens "kick-over" hazard. A counter-balanced motor can be cranked up or down for easy loadings.

The Dake Resin Mixer is available in three horsepower ranges and three disc diameters. Bulletin No. 425 offers complete specifications.



Taylor Ultrasonic Bubble Detector

Ultrasonic Bubble Detector

The Taylor Ultrasonic Bubble Detector, a product of Taylor Instrument Companies, 95 Ames St, Rochester 1, NY, reportedly can be used to detect undesirable or controlled bubbling in almost any liquid, in open or closed vessels, pipes or flumes. Whether the liquid is static or flowing does not effect instrument efficiency, it is claimed. The bubble detector can be coupled with any type of indicating, recording or controlling instrumentation, or simply with some type of alarm.

Use of the unit on actual product production runs, and in field and laboratory tests, reportedly has established a considerable backlog of application criteria. Individual bubbles reportedly are detected as readily as large quantities and the strength of the output signal varies with both the size and number of bubbles.

The sensing head assembly, located at the process, is cable connected in a continuous loop with the amplfier unit, which may be remotely located. A pulsed ultrasonic signal passes through the liquid which is likewise flowing between the transmitter and receiver heads. The presence of bubbles naturally weakens or interrupts the signal.

The amplifier unit is comprised of four sub-assemblies: a transmitter (the source of the signal passing through the head assembly); a receiver amplifier (which accepts the signal from the receiver head and provides a stabilized output); a power supply (containing the necessary rectifiers and regulators for excitation of the transmitter); and an operational analyzer (which eliminates the need for external calibration and test equipment).

No air supply is required for instrument operation and a safety factor is the use of a nonradio-active power source. The detector output requires no further amplification. Specifications are as follows: Minimum bubble size which may be detected: .001 inch diameter. Maximum temperature, head assembly: 180°F. Maximum temperature, amplifier assembly: 135°F. Maximum pressure, standard head assembly: 100 psi. Material of construction, head assembly: 316 stainless steel. Standard head assembly size: one inch. Fluid viscosity range: 1-30,000 centipoise. Maximum distance between head assembly and amplifier: 20 feet. Line voltage: 117 volts plus or minus 10% 60 cycle, 75 Watts. Output: 0 to 4 milliamperes into 2500 ohms (3 to 15 psi extra optional). Amplifier response time: less than .1 second for 63%.

To aid in determining the feasibility of application, request "Technical Sales Letter No. 6" and a "Bubble Detector Flow Data Sheet" from the Taylor Instrument Companies, Rochester 1, New York.

●

Asco Rotary Seal Gland

The Asco Rotary Seal Gland, a product of Arthur F Smith, Inc, 311 Alexander St, Rochester 4, NY, is a low-friction rotary mechanical seal of inert materials. It is constructed of Teflon, contains inner and outer O-ring seals of Viton "A", and ceramic seal components. It reportedly offers many advantages over mercury-sealed or precision-bore stirrers. It is available in four sizes, 24/40, 29/42, 34/45, and 45/50, standard taper; 24/40 and 29/42 supplied for six mm shaft or tubing. 34/45 and 45/50 can be supplied in either six- or 10-mm size.

The Asco Rotary Seal Gland is said to be vacuum tight to 10-8mm Hg and adjustable to variations of glass rod diameters. Power consumption or shaft drag is reported to be negligible. It operates at temperatures as high as 200°C, and is noncontaminating since vacuum tight O-ring seal eliminates need for greases, it is claimed. According to the manufacturer, it will not freeze, is nonbreakable, will not wear loose, and is suitable for use with any materials except metallic sodium.

●

Syl-soft 14

A new softener primarily designed for "wash-and-wear" fabrics, but said to be useful wherever a lubricant is needed, has been developed by Dow Corning Corp, Midland, Mich.

The new finish, called Syl-soft 14, is a silicone-based emulsion that is said to be compatible with a wide variety of finishing agents.

Chemically, the new finishing agent is a stable, milky-white, water-dilutable emulsion of reactive silicone fluids. Only a small amount is needed to improve hand, tear strength and sewability of most fabrics, the company states. A pick-up of one to two percent as supplied is said to be sufficient for most uses.

Syl-soft 14 is recommended by Dow Corning for resin finishing of cotton. The emulsion reportedly is nonionic, can be used with most resin finishing formulations, and requires no additional curing. It is claimed that this silicone will cure at the same temperatures required to cure organic finishing agents and is not removed during afterwashing or other treatments normally given resin-finished goods.

The finish is added to the resin formulation after the resins are dissolved and the solution cooled to below 120°F. Dow-Corning recommends that any resin catalyst required should be added last.

Syl-soft can also be used on man-made fibers and blends as well as on woolens and worsteds to add a luxurious hand, it is claimed.

Abstracts———

(*continued from page 48*)

backing fabric, but it also serves to give added weight and improved handle to the finished carpet. The latex is usually applied by means of a contact roller. The carpet is fed under tension with pile upwards over the roller, which rotates in a trough. It then passes over a doctor blade which scrapes excess compound from the surface.

Immediately after this application the carpet continues into an oven where both hot air and infrared drying equipment is used. The temperature is important, since if it is too low, the latex will be undercured, resulting in a considerable loss of strength in pile anchorage, and an odor may also occur.

Within the last year foam backing has become popular on tufted carpets. The thickness of the foam usually varies from ⅛″ to ¼″, depending on the construction.

A "scrimming" operation is also described, consisting of the application of a "light paper yarn scrim (or jute)" to the back of the carpet to give a nonslip finish coupled with dimensional stability.

●

Stabilizers in Bleaching Processes

Anon, *Textile Recorder* 77, #923, 68, 70; #924, 89, 91, 85 (1960)

The stabilization of bleaching solutions to prevent loss of oxygen is a matter of the first importance in textile processing.

The author discusses the use of various stabilizing agents and the incidental problems arising from their application.

Hydrogen Peroxide Solutions. Commercial grades of H_2O_2 sold today at 90% strength are highly stable. Since an acid solution of peroxide is more stable than an alkaline solution, it was customary at one time to add a certain amount of acid to the concentrated solution as a stabilizer. This is no longer necessary. If the peroxide contains a minute amount of iron (eg, one part in ten million), catalytic decomposition is likely to occur even at pH 3.

Sodium silicate is by far the most widely used stabilizing agent for peroxide bleach baths. It is very effective especially at high pH values, and at temperatures of 180-210°F. A high degree of purity is essential, as impure silicates will bring about release of oxygen and other undesirable effects.

Pyrophosphates, which are useful stabilizers at low alkalinity (pH 8-9.5) and a temperature of 120°F, are said to lose their stabilizing power, tending to revert to the orthophosphates, if used at high temperatures.

Silicate is also used in the one-stage peroxide bleach, in which the bleaching is done in kiers under low pressure for three to five hours. An interesting point here is the stabilizing effect of the impurities in the grey cotton, which act as a buffer against a rapid release of oxygen during the bleaching period.

It is now known after many years of experience with peroxide bleaching that hard water has a more stabilizing effect on the bleach bath than soft water. For this reason, if soft water only is available, it is usual to add small amounts of magnesium sulfate (Epsom salts) to the bath.

The author calls attention to the fact that, if the water contains iron, the presence of silicate seems to result in the formation of a complex with un-ionized iron, thus rendering it much less harmful.

Sodium Chlorite Solutions. Phosphates have been proposed as stabilizers for chlorite bleaching solutions, to prevent rapid decomposition and evolution of chlorine dioxide fumes.

At temperatures of less than 60°C, aqueous sodium chlorite (0.1%) is stable for six hours at pH 7; when acidified with hydrochloric or acetic acid, its stability is reduced.

Ten references to the literature are cited.

●

Cotton Quality Study. IV. Resistance to Weathering

Howard, J W and McCord, F A, *Textile Research J* 30, 75-117, Feb, 1960

Weathering is an inclusive term describing the aggregate effect of environmental factors of sunlight, microorganisms, industrial fumes, rain, and wind. Few materials escape the destructive action of the weather. During service few cotton products completely avoid exposure to the degradative action of weather, and for many uses weathering is a major consideration.

Cotton long has been and still is the principal fiber used in outdoor fabrics. Because of the multitude of end-uses, cotton fabrics are subjected to a wider range of weathering conditions than any other textile material. Cotton textiles are employed in such varied civilian and military outdoor products as tents, tarpaulins, awnings and truck covers, to name only a few.

Weatherproofing finishes for cotton offer the chemical industry potentially large markets if more efficient, economical treatments can be developed. This report points out where and to what extent the need and opportunity exists for improving cotton's weather resistance. Its purpose is to stimulate research by reviewing and condensing technical knowledge in the field and by suggesting new approaches for further study.

Following is a brief summary of the 40 pages of statistics in this voluminous report:

Part I. *Market Analysis.* There are tables giving the estimated consumption of materials in various uses, 1) subjected to outdoor exposure (eg, awnings, tents), 2) subjected to long exposure to sunlight and wind, etc (eg, curtains, auto upholstery), 3) subjected to microbial attack not due to outside exposure (eg, shoe linings, towels).

A long table gives the competitive factors (of other fibers competing with cotton) in various end-uses in which resistance to weathering is important. There are 37 different classifications of materials.

Part II. *Technical Section.* The structure of cotton is briefly described. The deterioration of cotton textiles from weathering may be due to chemical action, chiefly photochemical and microbial (eg, mildew and rot), or physical, including rubbing, flexing, abrasion and freezing. Various protective treatments are discussed.

Numerous methods for evaluating the weather resistance of cotton textiles are described.

The report closes with suggestions of opportunities for future research including both additive treatments and chemical modification of the cotton fiber.

There are 342 references to the literature.

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Reactive Dyes for Nylon

Scott, D F and Vickerstaff, T, *J Soc Dyers Col* 76, 104-12, Feb, 1960

Conventional dyes for nylon have suffered hitherto from the disadvantage that those of good fastness properties do not readily cover the chemical and physical irregularities of the fiber, while those which are free from these defects have relatively low fastness properties.

A new range of reactive dyes for nylon, the Procinyl dyes, has now been developed. They are disperse dyes and can be applied in an unreactive form under acid conditions, when they possess the level-dyeing

properties of disperse dyes. When the dyebath is made mildly alkaline, reaction occurs between dye and fiber, and a fast, level dyeing is obtained. It has been found that these dyes react both with the amine end-groups and with the amide groups in the fiber, so difficulties associated with saturation of amine end-groups are not encountered.

Rates of dyeing and fixation of the dyes have been determined both separately and in mixtures, and it is shown that the dyes are compatible for dyeing as mixtures. Rate-of-dyeing curves indicate that these dyes behave as medium-to-slow dyeing disperse dyes.

As with Procion dyes when applied to cellulose, a side-reaction with water occurs in the dyebath, and in this case the deactivated dye remains on the fiber after the soaping treatment which follows dyeing. Since, however, the unfixed dye has fastness properties at least equal to those of conventional disperse dyes, this small proportion can be tolerated without undue loss of fastness.

The Procinyl dyes may be printed on nylon, using a printing paste containing acetic acid and sodium acetate, which during the steaming process develops slight alkalinity, thus providing conditions for reaction to take place.

As would be expected, the authors state, the washing and heat fastness properties of the Procinyl dyes are excellent and much better than those of conventional disperse dyes, whereas the lightfastness is of the same order.

It is pointed out that this process of dyeing nylon is simple, may be caried out in conventional machinery, and does not entail the use of abnormal dyeing conditions or special reagents. By the use of Procinyl dyes it is now possible, the authors state, to dye nylon textiles to fast, bright colors with excellent coverage of fiber irregularities.

Seventeen references to the literature are cited.

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The Dyeing of Anodized Aluminum

Noonan, J D, *Dyestuffs 43*, 121-31, March, 1960

Colored anodized aluminum has advanced to the production point where it is not a new decorative finish. It now has aesthetic and practical value in a myriad of end uses.

The anodizing of aluminum is an electrolytic process of producing an anodic film consisting of layer upon layer of aluminum oxide on base metal. Sulfuric, chromic and oxalic acids are used as electrolytes in this process. Sulfuric acid is most commonly used in this country.

The anodic film exhibits small pores created by the solvent action of of the electrolyte on the aluminum oxide. It is believed that the substantivity of a dye for anodized aluminum is dependent on whether the dye can be adsorbed at the anodic film surface, and whether its molecular size is small enough to diffuse into the anodic pore. Porosity, as a function of pore size and film thickness, will govern: first, which dyes can pass into the pores, and second, how much dye can be retained. Anodizing conditions, therefore, greatly influence the dyeing results obtained.

In order to obtain maximum lightfastness, the dye used should be selected with care. At the present time, only a few of the many dyes offered by the manufacturers are suitable for the prolonged outdoor exposure necessary in architectural applications. The author lists several dyes which have been exposed for five years without failure.

An investigation was made of the effect of varying the anodizing conditions on the lightfastness of dyes. The results indicated that the lightfastness is improved as current density and the time, temperature and concentration of electrolyte are individually increased. All dyeing was conducted in the optimum range, 150-160°F. A long list of suitable dyes will be found in *Dyestuffs 41*, 185-93 (1956).

Since anodic coatings are soft and porous, a sealing treatment after dyeing is necessary to render the film nonabsorptive and impervious to handling. The following sealing compounds were tested, all applied in aqueous solution for 30 minutes just under the boil on six different dyes: nickel acetate and boric acid, lead acetate, zinc chloride, chromium sulfate, copper sulfate, potassium dichromate, and ferrous sulfate. The effects of these treatments on the shade and lightfastness of the dyes are tabulated. The nickel acetate/boric acid treatment had the least effect on shade, while the copper sulfate treatment improved the lightfastness the most.

A number of the dyes certified by the Food and Drug Administration are also suitable for dyeing anodized aluminum.

Six references to the literature are cited.

The Relation of Wet and Dry Crease Recovery to "Wash-wear" Behavior

Steele, R, *Textile Research J 30*, 37-46, January, 1960

The author reviews the chemical changes in the cellulose fiber which lead to various wet:dry crease-recovery ratios, and refers to a number of earlier papers on this subject. He points out that wet and dry crease recovery tests are measures of changes in fabric properties which are of major importance in determining "wash-and-wear" behavior.

He reminds us that the "wash-wear" behavior of cellulosic fabrics is affected by other factors than those which are measured by crease recovery. Fabric construction, color, and pattern are undoubtedly important, as well as the type of washing and drying procedures used. However important these may be, says he, there are two principal first-order effects which are related to the chemical finishing the fabric receives. One is the nature of the treatment which leads to changes in wet and dry crease recovery, and the other is the drying method employed in the washing procedure.

Tumble-dry "wash-wear" behavior is related to wet and dry crease recovery and both must be increased to achieve good "wash-wear" performance on cotton and rayon. In line or drip drying, wet crease recovery is a more significant factor than dry.

Concurrent increases in wet and dry recovery can be obtained by finishing agents which reduce interchain slippage, and the most effective agents are those which form covalent cross links between the cellulose chains.

Covalent cross-linking of a dry fiber enhances both wet and dry recovery, and the ratio of the two values is believed to depend on the relative accessibilities of the fiber to water and to the cross-linking reagent. Water-sensitive links between cellulose chains can give high dry and low wet crease recovery. Cross-linking reactions carried out when the fiber is wet and swollen lead to a higher degree of interchain reaction, which is equivalent to substitution, and to some interchain cross links. The swelling of such a fiber in water leads to good wet crease recovery, although the dry recovery is not improved.

Twenty-five references to the literature are cited.